# ASTRONOMY®

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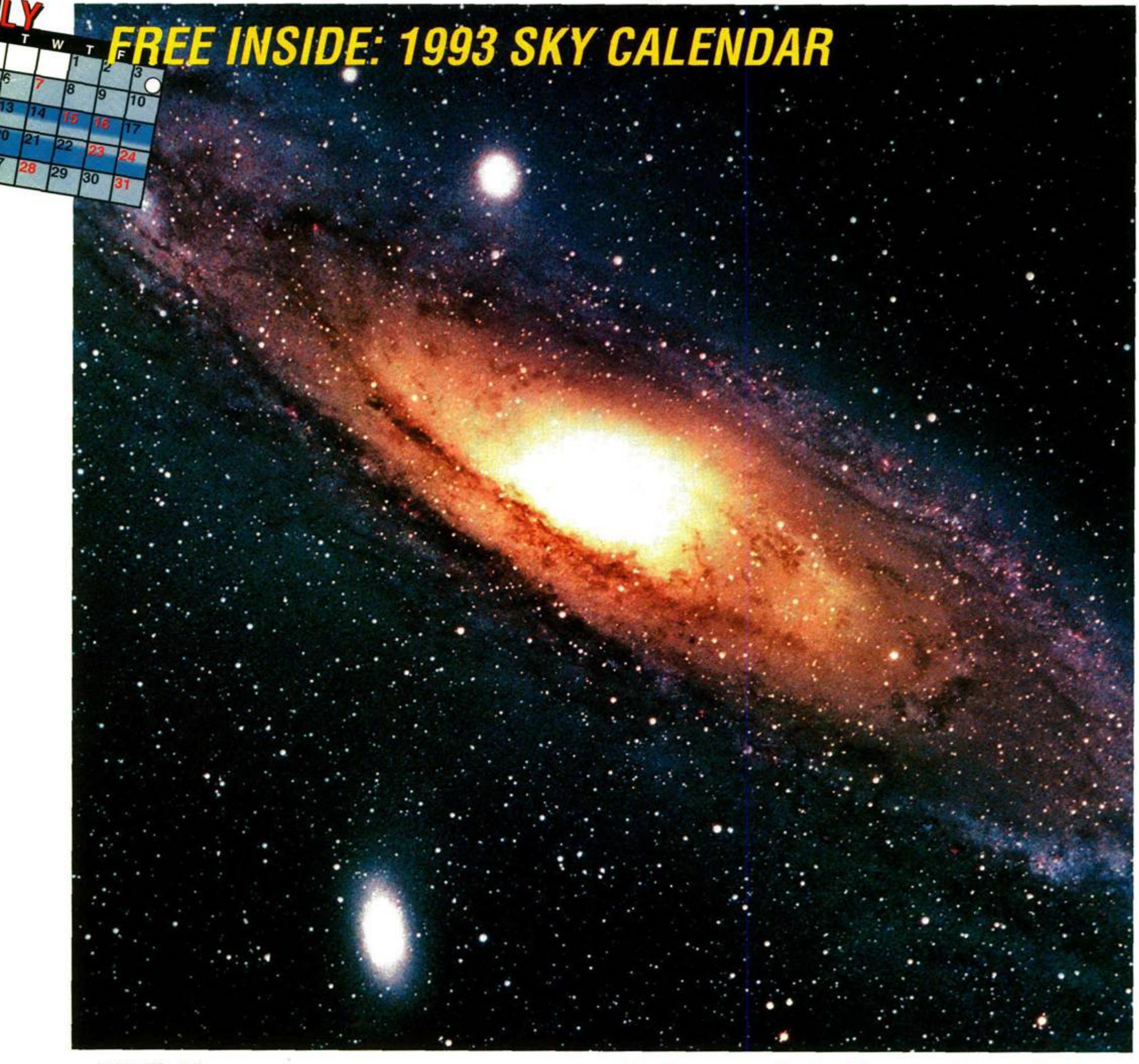
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## Andromeda's Showpiece Galaxy

# MEADE

"...The optics: all I can say is 'superb'...I could not believe the colour correction I was seeing...We took the [4"] scope up to 360X and the image did not degrade at all... The double-double was like four 'bullet-holes' and showed not a hint of astigmatism or overcorrection...a remarkable scope...colour correction of the Meade 5" is as perfect as I've ever seen in a refractor..."

**Meade complete ED Apochromatic Refractors** include optical tube assembly with giant 2.7" rack-and-pinion focuser, equatorial mount, field tripod, 8 x 50mm viewfinder, giant 2" diagonal mirror, and Super Plössl 26mm eyepiece:

| | |
|---|---|
| **4" f/9 Model 102ED, complete** | **$1995.** |
| **5" f/9 Model 127ED, complete** | **2495.** |
| **6" f/9 Model 152ED, complete** | **3995.** |
| **7" f/9 Model 178ED, complete** | **4995.** |
| **#1664 Electronic Drive System** | **375.** |
| **#1697 Computer Drive System** | **695.** |

Packing & shipping in the 48 states: 4"—$105; 5"—$125; 6"—$185; 7"—$215.

MEADE 152ED/APO SMC
MEADE 102ED/APO SMC
MEADE SMART DRIVE
Meade
Meade LXD 600

**Meade Model 152ED:** 6" f/9 ED Apochromatic Refractor. Shown with optional #1697 Computer drive System.

Meade super multi-coated ED apochromatic objective lenses yield ultra high resolution, high contrast images virtually free of any false color.

Ten or more internal light baffles effectively eliminate any stray light reaching the focal plane.

6" and 7" models include the LXD 700 Equatorial Mount and giant field tripod.

LXD 600 and LXD 700 equatorial mounts include 8 ball bearings (4 on each axis!) and worm gear controls on both axes.

**Meade Model 102ED:** 4" f/9 ED Apochromatic Refractor. Shown with optional #1664 Electronic Drive System.

4" and 5" models include the LXD 600 Equatorial Mount and standard field tripod.

Standard accessories include 8 x 50mm viewfinder, 2" diagonal mirror, Super Plössl 26mm eyepiece.

Optional #1697 Computer Drive System has 4 drive speeds on both axes: 2x, 32x, 2° and 8° per second.

Press the keypad controller buttons of the #1697 Drive to move the telescope across the sky electronically. Enter any one of 747 standard objects (or one of 8000 optionally available library objects), press GO TO and the telescope slews directly to the object.

Enter in the keypad the RA and Dec of any object, press GO TO, and the telescope automatically slews to the object at 8° per sec.

Optional #1664 Electronic Drive System has 2 drive speeds on both axes: 2x, 32x.

NOW AVAILABLE FOR PROMPT SHIPMENT.

# OBSERVER REPORTS: *ED* APOCHROMATIC REFRACTORS

**Never in the 20-year history of Meade Instruments has a new telescope series been so thoroughly tested—and received such acclaim—by some of the world's most demanding and discriminating astronomers. A sampling of the reports we have received on Meade ED Apochromats:**

*"As an apochromat* **and** *Schmidt-Cassegrain enthusiast of 22 years standing, I have been more than a bit anxious to get my hands on the new Meade APO's and LX200 SCT's. I think it is paramount that a "mainstream" company has gotten involved in the development of apochromatic refractors, so the average person does not have to pay a fortune and wait almost a year to get a quality, high-performance refractor. With some friends, I recently put the Meade 4" 102ED and 10" LX200* [See the Meade LX200 ad of this issue] *through extensive testing. The 4" was virtually perfect. The mount was very solid and the computer drive made finding objects in light-polluted North York very easy. The fast electric slew feature was much appreciated because it eliminated the need ever to loosen the RA and Dec locks. Set-up and orientation of the scope were easy as well. The optics: all I can say is "superb." We looked at Saturn, Epsilon Lyrae, M13, and other Messier objects, and all were excellent. I could not believe the colour correction I was seeing: I detected no on-axis colour whatever. We took the scope up to 360X and the image did not degrade at all. Saturn was very detailed and the contrast of the equatorial band on the planet and the variation in the planetary colours was amazing for a 4" refractor. The double-double was like four "bullet holes" and showed not a hint of the astigmatism or overcorrection I have seen in so many other APO's claiming to be "state-of-the-art." The Meade 102ED is a remarkable scope. Any scope that can support almost 100X per inch is a first rate instrument—I have seen too many other APO's fall apart at 50X and even 30X per inch."*—**Richard Anderson, Mississauga, Ontario, Canada**

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*"Further to my letter regarding your 4" APO, I thought you might like to hear the results of tests on your 5" APO at the recent Canadian Starfest convention. Through the 5" Saturn was terrific. Aside from the usual things such as the Cassini division, I could see the olivine cap on top of the ball, as well as subtle detail in the main equatorial belt. What really struck me as amazing was the true-to-life colour rendition the APO provided.* ***The colour correction of the Meade 5" is as perfect as I've ever seen in a refractor.*** *When I compared the Meade APO to a few* [competing brand of] *refractors, I was seriously wondering why anyone would pay the prices they charge—on all objects the Meade was as good or better. The diffraction disks of stars were more accurately rendered in the Meade than in the* [competing brand of] *6" APO at the site. I can wholeheartedly recommend the Meade 5" APO. In terms of comparison to other brands on the market, the Meade is superior."*—**Richard Anderson, Mississauga, Ontario, Canada**

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*"I've been an amateur astronomer since 1959 and have observed through all manner of telescopes large and small, up to 40" aperture. I am writing to tell you that images through the Meade 6" ED/APO are absolutely stunning even by professional standards. Image contrast and definition are amazing. The quality and workmanship are flawless. Having joined the A.L.P.O. in 1965, I can only speculate on how much additional and useful observational work could have been accomplished, had quality apochromatic refractors such as this been available those many years. The image quality even to the edge of the field is outstanding, while the color correction and contrast are simply better than any telescope I've ever used."*—**Orville H. Brettman, Past President, The Astronomical League, Huntley, IL**

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*"In this country where apochromatic refractors are used by almost half of all serious amateurs, the introduction of Meade American-made ED/APO refractors was frankly met with some skepticism. This skepticism has dissolved rapidly, however, as word has spread about these very fine instruments. My personal tests with the Meade 5" ED have proven that this lens is clearly the equal of the finest Japanese ED lenses. Images through the Meade 5" ED are of high contrast and I could see no false color even at high power. Diffraction rings are virtually perfect. Using the computer drive, the telescope centered objects automatically and greatly increased my observing efficiency. Thank you for giving Japanese amateurs a chance at reasonable cost to use high-performance, large-aperture ED refractors."*

**—Tadashi Sudoh, Tokyo, Japan**

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*"Last night I used the new Meade 6" and 7" ED apochromatic refractors. These are, without a doubt, among the finest telescopes I've ever used. Period. The LXD 700 equatorial mount is truly a remarkable telescope mount. The computer control is no less than startling. After spending 3 minutes polar aligning the mount, I then entered the command to find Saturn. The motors of the huge 7-incher slewed directly to the planet and placed it exactly in the center of the field of the 4.7mm eyepiece. And the views: I have never seen such razor-sharp images of Saturn before. Both scopes gave exceptional images. Stars are like tiny pinpoints. I could go on and on, but suffice it to say, these telescopes are really astounding."*—**Darrell Green, Burbank, CA**

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*"I just wanted you to know how thrilled I am with my new 4" 102ED refractor. My standards for precision optics are exceedingly high; I am an eye surgeon and routinely use an $80,000 state-of-the-art microscope to perform cataract surgery. I'm happy to say that every aspect of the scope lives up to my standards and expectations. The mount is extremely rigid with excellent vibration dampening characteristics. The #1697 computer drive performs flawlessly. Lastly, and most importantly, the optics are superb. Planetary and lunar contrast and detail are simply breathtaking. My sincere thanks for the obvious thought and dedication that your company put into this magnificent precision instrument."*

**—Barry S. Seibel, M.D., Los Angeles, CA**

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*"I had my first look through the Meade 6" APO at the 1992 Astrofest Star Party. While the lines were long in anticipation, I finally feasted my eyes on Saturn and was literally knocked back by what I saw. Not only was Saturn huge in the 240X field, but almost three-dimensional as well. As I studied the image, I remembered the old saying "Good things are worth waiting for," and this telescope is worth every minute."*

**—Vic Winter, Kansas City, MO**

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*"At a recent star party many apochromatic refractors were set up, including a 6" Meade ED/APO. All during the evening I walked back and forth among these telescopes, carefully comparing relative optical performance. After looking through several 6"* [competing brand] *3-element APO's (both cemented and air-spaced designs), I noticed in all of these scopes that Saturn's minor ring divisions, Cassini division, and the ball of the planet were not of the same contrast brightness, but seemed to vary inconsistently. Some areas of the planet seemed "underexposed," while other areas with potential detail appeared subdued. I repeatedly went back to a 3-element 6" f/12* [competing brand] *planetary APO, but found that all of the 3-element APO's had the contrast problem. Amazingly, the Meade 6" f/9 ED air-spaced doublet APO produced a brighter image with increased sharpness, allowing features to be seen more clearly than through competitive triplets. "Brighter, clearer, sharper" is the way I would describe the Meade APO when compared directly to lenses of other designs."*—**Robert Petti, Lyndhurst, OH**

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☐ **For further information on Meade ED Apochromatic or Schmidt-Cassegrain telescopes, visit one of the hundreds of Meade dealer showroom locations throughout the USA; or contact one of the authorized mail-order dealers at left. Or call Meade Instruments toll-free at 1-800-854-7485 (in California 714-556-2291).**

☐ *All prices shown are suggested USA mail-order retail prices, exclusive of sales taxes or credit card charges, if applicable.

☐ The all-new **1992 Meade General Catalog—$3.00** postpaid—is available from any authorized Meade dealer or directly from Meade Instruments.

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**ON THE COVER:** Spiral arms laden with bright stars, gaseous nebulae, and dark dust lanes swirl around the central hub of the Andromeda Galaxy (M31). A visitor approaching the Milky Way Galaxy would enjoy a similar view. See page 32 to experience our Galaxy through a visitor's eyes. Photo by Tony Hallas and Daphne Mount.

**THE FULL MOON BRIGHTENS** a wintry landscape in this double exposure by Bill Hood. Hood is one of several gifted astrophotographers who share their love of photographing the night sky with ASTRONOMY's readers this month. (See page 70.)

Bill Hood

20th ANNIVERSARY YEAR

# ASTRONOMY

January 1993

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**1993**

**SKY CALENDAR**

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The
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## Behind the Scenes

# TAKING A LONG VIEW

From cities, and even from most suburbs, the glow of manmade lighting hides the Milky Way from view. You usually have to travel out into the countryside to see it, but even so it's well worth the trip. The Milky Way is what our home Galaxy looks like as seen from the inside.

The Milky Way in winter is dim compared to summer's splendid display. What catches the eye these chilly evenings are mainly the handfuls of bright stars strewn across Orion and Canis Major, Gemini and Auriga. The difference between summer's Milky Way and winter's is not just coincidence. It comes from a basic astronomical fact: the Sun does not reside near the center of the Galaxy. If it did, the Milky Way would be bright all year round. So in its own way, the night sky is telling us that our star and its planets lie on the galactic periphery.

From Earth it's hard to gain a sense of our Galaxy's real shape, size, and contents. We're too immersed in it. To see the Galaxy as it really is, we have to use our imagination and stand outside it. On page 32, astronomer Gerrit Verschuur launches a grand journey. Starting from the Large Magellanic Cloud, one of the Milky Way's companion galaxies, Verschuur points our gaze upward into the sky of an imaginary alien planet — and shows us our galactic home spread out before us.

Then he takes us into the Galaxy itself. We coast past its dark outskirts, thinly populated with stars. Then diving deeper we overtake star clusters, gas clouds, and dusty stellar birthplaces. Some features of the Galaxy are familiar objects we can see with a backyard telescope or even the naked eye. Others can be seen only by instruments that see the "light" of other wavelengths than the visible — radio waves, far ultraviolet, or X rays.

Finally, having probed the near, the far, and the familiar, we plunge into the Galaxy's heart to explore its mysterious center. What lies there? A black hole? A giant cluster of stars and gas? No one really knows for sure, although astronomers have plenty of guesses. It's an exciting journey. And one that I think will change the way you look at that lovely silver band of stars that encircles the sky.

I'm delighted to note that 1993 is ASTRONOMY's 20th-anniversary year. (Our first issue was August 1973.) If you look back on issues from then, you'll be amazed at the changes in amateur astronomy. In ideas, information, and equipment, we have grown much more sophisticated and today have wider choices and far better telescopes than we had back then. The past 20 years have seen the greatest-ever growth in amateur astronomy, and ASTRONOMY is very proud to have been part of it. If backyard astronomers have achieved this in just two decades, it's exciting to think what lies ahead in the next 20 years.

Sincerely,

Robert Burnham
Editor

ASTRONOMY

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## Letters

### Two Views of Space

Although I enjoyed Ken Croswell's article on exploring Neptune and Pluto ("To the Edge," May 1992), I find it hard to believe that in the days of America's financial decline, the space agency would fund a mission to the outer solar system. The pinnacle of American achievement was to land a man on the Moon. Unfortunately, Reaganomics abruptly ended an era of scientific leadership and innovation.

The savings and loan crisis, swelling unemployment, inner city deterioration, and a $3 trillion deficit are now America's priorities. These days I believe America must take a back seat to rising Japanese and German interests. The space game is for those who can afford to play. America has had her day in the sun. Now it's time for new players and innovations from sources such as the European Space Agency. — *Kenneth Hueston, Edmonton, Alberta, Canada*

Several months ago the Japanese Speaker of the House, Yoshio Sakurauchi, touched a national nerve when he made his statement about American workers' not working hard enough. His comment sparked a rash of Japan-bashing in this country.

In stark contrast to Sakurauchi's negative comments, here's what Japanese Premier Eisaku Sato said after watching the first Moonwalk in 1969: "Splendid — they've done it. I never thought such an event would take place in my lifetime." At that time, Japan and the rest of the world were in awe of what Americans could do. What should make us take notice, however, is that the example most often given of extraordinary American achievement took place almost 25 years ago. And it took place in space.

Today, however, under the leadership of the United States, more than a dozen nations, including Japan, are participating in the Space Station Freedom project. When fully assembled a few years from now, the station will serve as a great example of American ingenuity and productivity. — *Robert L. Villhard, Senior Engineer, Space Station Freedom, Houston, Texas*

### Dobsonian Balance Tip

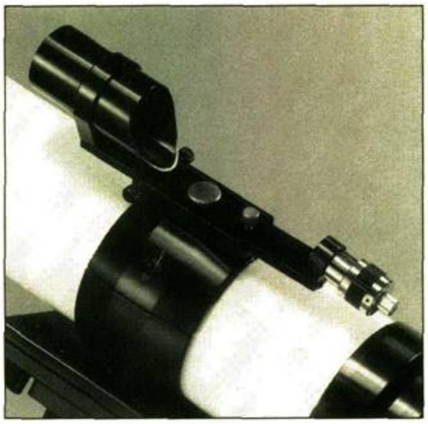
Here's an idea that should help anyone who has found that their Odyssey Dobsonian telescope is top heavy when fitted with a heavy eyepiece or a Telrad finder. Lumicon and Tuthill both offer vinyl dust covers for these telescopes. Placing the vinyl cover over the rear end

*[continued on page 12]*

# VISUAL & PHOTO ACCESSORIES

## STARBEAM

"Star hop" across the sky with Starbeam's 10 arc minute variable intensity "red-star." Peering through the 39mm diameter beamsplitting mirror/lens you'll see the natural sky background with a "red-star" where your telescope is pointed. The collimated image of the "red-star" appears fixed, no matter where you move your head! It's a snap to mount and align Starbeam to most any scope. Starbeam's sleek design is constructed of CNC machined, black anodized aluminum for beauty and durability.



## PARACORR

To get the most from your investment in high quality eyepieces for your Dobsonian/Newtonian you need Paracorr. Paracorr parabola corrector eats the coma produced by the mirror and lets your eyepieces perform! Without Paracorr an f/4.5 mirror has a diffraction limited field of only 3mm. Add Paracorr and that increases to 18mm. That's 36x more diffraction limited field area! Paracorr's multi-group design adds no aberrations. Paracorr is available in 2" photo/visual and 1¼" visual models.

**Holiday Gift Ideas**

**Even Better**

**Than You Imagined**

## CAMERA ADAPTERS

Secure your 35mm camera and T-ring to Tele Vue's ruggedly constructed Camera Adapter and Eyepiece Projection Adapter. CNC machined, black anodized aluminum and anti-reflection threads maximize contrast by preventing stray light from reaching the film. The 2" Camera Adapter features 48mm filter threads. For lunar and planetary photography, lock an eyepiece between the E.P.A.'s two halves to extend your scope's focal length. Use the E.P.A. with 1¼" filters in 1¼" and 2" focusers.

## QUESTAR ADAPTER

Unleash your Questar's potential with the "spacewalk" views of Tele Vue Plössl, Wide Field, Panoptic and Nagler eyepieces. This finely crafted adapter is CNC machined from solid aluminum stock to complement the Questar's beauty. The adapter's polished aluminum base has blackened anti-reflection threads on the inside aperture to improve contrast. The black anodized knurled ring allows focusing to Questar's viewfinder optics, and conveniently has two positions for the eyepiece lock screw.

*Tele Vue would like to introduce you to other fine items we offer: The Rich Field Kit offers 1¼" equipped Celestron and Meade SCT owners 2" capability for 3 times more true field. The kit includes our thread-on SCT adapter tube, 2" Star Diagonal, 55mm Plössl and 1¼" eyepiece adapter. We also offer various eyepiece adapters such as 2" to 1¼", 1¼" to .965" & .965" to 1¼", so all telescopes can take advantage of "Tack-Sharp" Tele Vue eyepieces.*

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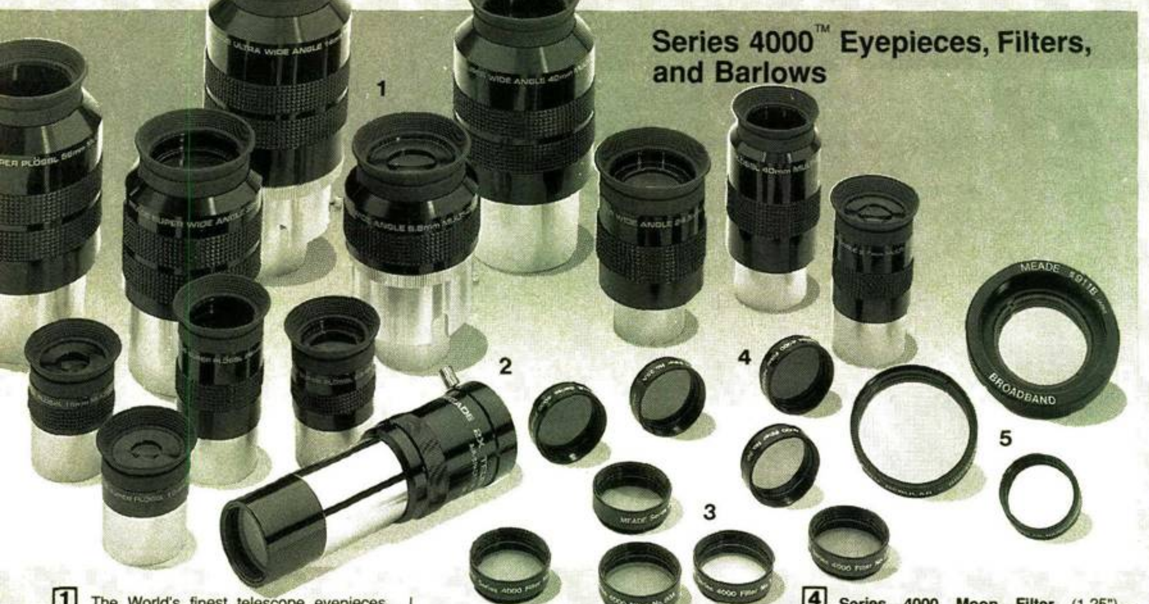


**1** The World's finest telescope eyepieces now include rubber grips and soft rubber eyeguards for an even better observing experience! All eyeguards fold down for eyeglass wearers—a feature not available on competing brands. Best of all, **Meade Series 4000's are guaranteed to deliver more field, more contrast, and more image sharpness than any other brand at any price, or your money back.*** For splitting the closest doubles, revealing tenuous, faint nebulosity in deep-space, or studying hairline lunar and planetary detail, Meade multi-coated Series 4000's are the oculars that serious observers insist upon. ***"Clearly the best."***

**Super Plössls** (5-elements; 1.25"; 52°):

| | |
|---|---|
| 6.4; 9.7; 12.4; 15; 20; 26mm ea | **$87.95** (3.29) |
| 32mm(52°); 40mm(44°); each | **109.95** (3.79) |
| 56mm (52°, 2") | **229.95** (4.18) |

**Super Wide Angles** (6-elements; 1.25"; 67°):

| | |
|---|---|
| 13.8mm: | **139.95** (3.29) |
| 18mm: | **149.95** (3.29) |
| 24.5mm: | **169.95** (3.79) |
| 32mm(2"): | **239.95** (4.18) |
| 40mm(2"): | **299.95** (4.18) |

**Ultra Wide Angles** (8-elements, 1.25"; 84°):

| | |
|---|---|
| 4.7mm: | **154.95** (3.29) |
| 6.7mm: | **187.95** (3.29) |
| 8.8mm(1.25"/2"): | **229.95** (4.18) |
| 14mm(1.25"/2"): | **269.95** (4.18) |

*at participating dealers; see catalog for details.

**2** **#140: Series 4000 2x Apochromatic Barlow Lens** (1.25")--The original Meade 3-element, air-spaced, multi-coated design. Absolutely unmatched in image resolution and color correction. 28mm dia. lens (26mm clear aperture). **$79.95** (3.29)

**3** **Series 4000 Photo-Visual Color Filters** (1.25")—Made of purest crown optical glass, dyed in the mass. For increased contrast on the Moon and planets . Thread into virtually all 1.25" eyepieces sold today. Fully coated.

**#8 Lt. Yellow; #11 Yellow-Green; #12 Yellow; #21 Orange; #23A Lt. Red; #25A Red; #38A Dark Blue; #47 Violet; #56 Lt. Green; #58 Green; #80A Blue; #82A Lt. Blue.**

each **$12.95** (2.29)

| | |
|---|---|
| **Set #1**—4 filters: #12 Yellow, #23A Lt.Red, #58 Green, #80A Blue | **$49.95** (2.79) |
| **Set #2**—4 filters: #11 Yellow-Green, #25A Red, #47 Violet, #82A Lt. Blue | **$49.95** (2.79) |
| **Set #3**—4 filters: #8 Lt. Yellow, #21 Orange, #38A Dark Blue, #56 Lt. Green | **$49.95** (2.79) |
| **Sets #1 & #2**—8 filters | **$89.95** (3.29) |
| **Sets #1, #2, & #3**—12 filters | **$129.95** (3.48) |

**4** **Series 4000 Moon Filter** (1.25")—Excellent for 4" to 12" telescopes. Reduces Moon brightness by 87%. **$15.95** (2.49)

**5** **Series 4000 Nebular Filters**—The very latest in multi-layer interference coating technology, Meade premium nebular filters are guaranteed to be the finest obtainable at any price. Use a Series 4000 Broadband filter to block most forms of light pollution, with minimal attenuation of desired wavelengths. Use a Narrowband filter in heavily light-polluted areas, or for extremely high contrast observing of faint nebulae.

**BROADBAND FILTERS**

**#908B** (1.25")—Threads into all Meade 1.25" eyepieces, and virtually all other brands. Full 26mm clear aperture. **$79.95** (2.49)

**#910B**—Threads into all Meade 2" eyepieces and most others; 44mm dia. **119.95** (2.79)

**#911B**--Threads on to the rear cell of Schmidt-Cassegrain telescopes. **99.95** (3.29)

**NARROWBAND FILTERS**

**#908N** (1.25")—Threads into virtually all 1.25" eyepieces; 26mm clear aperture. **89.95** (2.49)

**#910N**—Threads into all Meade 2" eyepieces and most others; 44mm dia. **129.95** (2.79)

**#911N**--Threads on to the rear cell of Schmidt-Cassegrain telescopes. **119.95** (3.29)

## World's Most Advanced Illuminated Reticle Eyepiece

**Series 4000 Plössl 9mm,** with rubber eyecup and micrometric X-Y positioning of the reticle within the field. Greatly facilitates locking on the guide star. Sharp high-power imaging, excellent eye relief. Wireless red LED illuminator with adjustable brightness control. Internal batteries included. Multi-coated optics. Bullseye reticle. 1.25" **$129.95** (3.29)

**Series 4000 Plössl 9mm**—Same as above but with 6 ft. cord and plug for Meade LX3, LX5, LX6, LX100, LX200, and APO power panels, in place of wireless illuminator. **$109.95** (3.29)

## MA 12mm Illuminated *Reticle Eyepiece*

Excellent 3-element optical system, long eye relief, fully coated, with double crossline reticle. Includes wireless red LED illuminator with internal batteries and variable brightness control. **$94.95** (3.29)

**MA 12mm**-Same as above, but with cord and plug for Meade telescopes with power panels, in place of wireless illuminator. **$74.95** (3.29)

## 2" Diagonal Mirror

**#929:** Permits use of wide-field 2" oculars. Threads on to rear cell of Meade and Celestron SCT's. Includes multi-coated precision optical flat made at the Meade factory; with 1.25" eyepiece adapter **$99.95** (3.29)

## Camera Adapters (1.25" & .965")

Professional-quality adapters for rigid coupling of telescope-to-camera. Use for either Eyepiece-Projection or Prime Focus. Precision-machined of aluminum and brass, threaded for filters. Use with T-Mount, available separately.

.965": **$27.95** (2.79) 1.25": **$29.95** (2.79)

## Variable-Projection Camera Adapter (1.25")

Machined sliding cell allows variable projection power in eyepiece-projection photography; permits precise selection of correct photo power in lunar and planetary photography; threaded for filters. Use with T-Mount for your camera. **$39.95** (2.79)

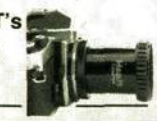
## Tele-Extenders

For Eyepiece-Projection photography with any Meade or Celestron SCT. Threads on to eyepiece-holder. Use with T-Mount for your camera.

**Basic Tele-Extender:** *(above)* Fixed projection power; use with eyepiece for lunar and planetary photos. **$29.95** (2.79)

**Variable Tele-Extender:** Sliding cell, with lock, permits wide range of projection magnifications with the same eyepiece. **$39.95** (2.79)

## T-Adapters for SCT's



For Prime Focus photography with any Meade or Celestron SCT. Use with T-Mount for your 35mm camera. **$26.95** (2.79)

## 2X Telenegative Barlow (1.25")

**#122:** Doubles eyepiece power with sharp, high-resolution, high-contrast imaging on telescopes of all types. 27mm dia. (26mm clear aperture). Excellent corrections for chromatic and spherical aberrations at all photo-visual wavelengths. Multi-coated. 1.25" **$47.95** (3.29)

## 2x-3x Variable Barlow (1.25")

**#127:** Precision internal sliding lens assembly permits continuously variable power settings between 2x and 3x. Engraved scale indicates power in use. Yields bright, sharp, high-contrast images on telescopes of all types. Multi-coated; 1.25" **$59.95** (3.29)

## Orthoscopic Eyepieces (1.25")

Fine 4-element oculars that yield excellent image quality with any telescope. Computer-optimized design provides wide, flat fields, highly corrected for spherical and chromatic aberrations. Parfocal, multi-coated, 1.25" barrels. Threaded for filters. **Focal Lengths: OR 4, 6, 9, 12.5, 25mm.**

each **$49.95** (2.79)

## Modified Achromatic Eyepieces

An improvement on the traditional Kellner design, the 3-element MA gives sharp, faithful, well-corrected images of the Moon, planets, and deep-space. Multi-coated; threaded for filters. 1.25" **Focal Lengths: MA 9, 12, 25, 40mm.**

each **$37.95** (2.79)

## Rack-and-Pinion Focusers (1.25")

The finest focusers in the industry. Meade rack and pinion mechanisms have precise, ultra-smooth action along the entire travel distance. Housings are machined for tight fit of the moving sleeve. All focuser models may be used on tubes of from 4" to 20" diameter; all accept 1.25" eyepieces. Mounting hardware included.

**#71**—The finest economical focuser available. Travel distance: 2.2" A precision mechanism, beautifully finished. **$44.95** (2.79)

**#67**—Includes spring-loaded gearbox for variable tension adjustment. Travel distance: 2.2". **59.95** (2.79)

## Rack-and-Pinion Focusers (2")

**#680--**The most popular 2" focuser ever manufactured. Thousands in use. Spring-loaded gearbox; 3" travel. Includes 1.25" and 2" eyepiece-holders. **99.95** (3.78)

**#682**—Low-profile 2" focuser; body height only 1.75". Spring-loaded gearbox. Travel: 2.5". Includes 1.25" adapter. **99.95** (3.78)

## Viewfinders: 30mm, 50mm, 60mm

**#637: 6 x 30mm**-Fine, 7° wide-field finder; coated, achromatic lens; crosshair eyepiece, 2-ring bracket with alignment screws. Attaches to tube diameters 6" to 12" **$49.95** (3.29)

**#545: 8 x 50mm**-*(lower photo)* Wide 5° field; coated achromatic objective; crosshair eyepiece. White tube. Ideal for telescopes of any aperture. See bracket below. **69.95** (4.28)

**#544: 8 x 50mm**-- Same as #545, but in Meade blue. **69.95** (4.28)

**#957: 9 x 60mm**---*(top photo)* Collects 44% more light than 50mm; superior for faint objects; bracket below. **99.95** (4.68)

**Bracket for 8 x 50mm:** Fits Meade and Celestron SCT's, and other tubes from 7" to 20" diameter. **17.95** (2.79)

**Bracket for 9 x 60mm:** Fits tubes from 7" to 20" diameter. Removable dovetail included. **22.95** (2.79)

## Multi-Coated Giant Binoculars

Superb, fully multi-coated 11 x 80mm and 20 x 80mm Giant Binoculars, ideal for wide-field deep-space observing. **Rubber-coated bodies for rugged field use!** BAK-4 prisms yield bright, sharp, high-contrast images. Hard carry case, tripod adapter included.

**11x80: $399.95** (7.27)

**20x80: $419.95** (7.27)

## 45° Erect-Image Diagonal Prisms

Originally developed by Meade Instruments, these convenient diagonals erect the astronomical image, for terrestrial use of astronomical telescopes. Fully coated.

**#927:** for .965" focusers.
**#928:** for 1.25" focusers.
**#931 Hybrid:** accepts 1.25" eyepieces, fits .965" focusers.

Specify model desired. each **$49.95** (2.79)

## HOW TO ORDER

■ Prices shown are suggested USA mail-order retail prices and do not include any applicable sales taxes.

■ Suggested shipping and handling charges to the 48 states by UPS or US Mail shown in ( ) next to each price.

■ Meade accessories may be ordered from any Meade Advanced Products dealer. **The following national mail-order dealers carry all Meade accessories in-stock for immediate shipment:**

**ASTRONOMICS, Norman, OK.**
**Orders: 800-422-7876; Info.: 405-364-0858.**

**CALIFORNIA TELESCOPE CO., Burbank, CA**
**Orders: 800-843-4780; Info: 818-505-8424.**

**FOCUS CAMERA, Brooklyn, NY.**
**Orders: 800-221-0828. Info: 718-436-6262.**

**LUMICON, Livermore, CA.**
**Orders: 800-767-9576. Info: 510-447-9570.**

**SCOPE CITY/Mail-Order, Simi Valley, CA.**
**Orders: 800-235-3344; Info/CA:805-522-6701**

**SHUTAN CAMERA & VIDEO, Chicago, IL.**
**Orders: 800-621-2248; Info/IL: 312-332-2000.**

***Canada:***

**KHAN SCOPE CENTRE , Toronto, Ontario.**
**Orders & Information: 416-783-4140.**

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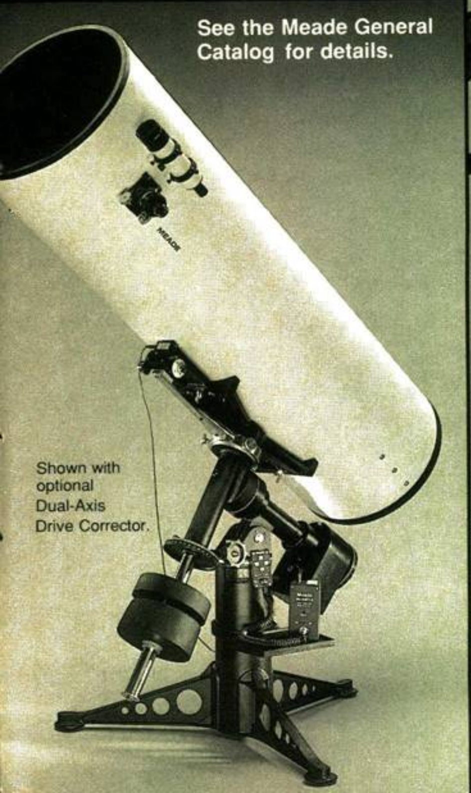
**Starfinder 16: 16" f/4.5 $1995.**

See the Meade General Catalog for details.



Shown with optional Dual-Axis Drive Corrector.

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Meade Starfinder 6", 8", and 10" reflecting telescopes offer the finest values available anywhere. **Standard equipment on all 3 models includes:**

■ **Superb Optical System:** Includes a Meade hand-figured parabolic primary mirror that meets the theoretical limit of resolution for its aperture, with matching elliptical flat secondary mirror. Both mirrors multi-coated and made of fine-annealed Pyrex® glass.

■ **Precision Equatorial Mount:** Manufactured of virgin aluminum castings machined to tolerances of .001" or better, and placed atop a 4"-dia. pier with die-cast tripod legs, yielding rock-solid support for the optical tube assembly. The telescope moves effortlessly from object-to-object on precision bearing surfaces. Polar and declination shafts are 1" solid steel. Setting circles on both axes facilitate the location of faint sky objects directly from their catalogued coordinates.

■ **Electric Motor Drive** (115v./60Hz) with 6 ft. power cord: Permits fully automatic tracking of celestial objects; plugs into any standard outlet.

■ **Accessories and Components:** Meade Starfinder telescopes include high-performance components throughout: **#71 Rack-and-Pinion Focuser** (1.25") for smooth, backlash-free focusing of the image; a coated achromatic **#637 6 x 30mm Viewfinder** with crosshair eyepiece and 7° field, for quick object-locating; **coated MA 25mm** (1.25") eyepiece; strong, durable spiral-wound **optical tube** with attractive white finish; and **cast aluminum mirror cell** for accurate mounting and alignment of the primary mirror.

■ **Optional Accessories:** See the opposite page for some of the many optional accessories available. Additional systems, including the **#55 Manual Declination Control**, **#43 Drive Corrector** and **#47M Dual-Axis Drive Corrector,** are described in the **Meade General Catalog.**

**A Meade Starfinder telescope** opens up the skies to an extremely wide range of serious visual observing, to lunar and planetary photography, and even to limited deep-space photography. And every telescope is backed by the World's largest manufacturer of serious telescopes.

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■ **Packing & UPS Shipping Charges to any address in the 48 states: 6"--$50; 8"--$60; 10"--$75.**

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■ **The 1992 Meade General Catalog—$3.00 postpaid—is available from any authorized Meade dealer or directly from Meade Instruments.**

■ **For further information call Meade Instruments toll-free at 1-800-854-7485 (in Calif. 714-556-2291) or contact one of these authorized mail-order dealers:**

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**ASTRONOMICS, Norman, OK.**
**Orders: 800-422-7876; Info.: 405-364-0858.**

**CALIFORNIA TELESCOPE COMPANY, Burbank, CA.**
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**LUMICON, Livermore, CA.**
**Orders: 800-767-9576; Info.: 510-447-9570.**

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**Orders: 800-235-3344; Calif. and Info.: 805-522-6701.**

**SHUTAN CAMERA & VIDEO, Chicago, IL.**
**Orders: 800-621-2248; Illinois & Info.: 312-332-2000.**

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**KHAN SCOPE CENTRE, Toronto, Ontario.**
**Orders and Information: 416-783-4140.**

*ADVANCED PRODUCTS DIVISION* **Meade Instruments Corporation**

# OBSERVER REPORTS: *LX200* SCHMIDT-CASSEGRAINS

**"...After hours and hours of using this instrument, it is clear the quantum leaps that Meade has made in telescope technology...Planetary contrast and detail were simply unlike any 8" SC telescope that I had ever tested before...The more people looked, the faster word spread that something truly extraordinary was going on..."**

*"Last weekend I arrived at our club's dark sky site and set up next to a brand-new 8" LX200 owned by Mark, one of our club members. This was going to be a fun evening. Mark punched in a request for M57, the Ring Nebula. Less than 10 seconds later there it was, exactly in the center of the eyepiece! Very sharp image too. Next we tried a long slew, off to M31, the Andromeda Galaxy. Took about 15 seconds and there was the core of M31, again centered in the eyepiece. We punched in a request for Saturn. The scope buzzed over and centered the beautiful ringed planet (this could make a finderscope obsolete!). We ran the power up on Saturn. The LX200 gave a splendid view. Sharp image, lots of contrast. Refractor-like. The optics on this scope were outstanding, and the combination of ease of use and superb optics was impressive. This scope had better contrast and much sharper optics than I've seen on other SC's. One of the club members went inside to call his wife and let her know he was buying one. Congratulations! This is a very desirable scope you've created."*—**Bob Beckley, Bedford, MA**

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*"I have made my best purchase of a lifetime. I saved for two years to have a superior telescope of my dreams and you have made them come true with the 10" LX200. The optical quality one must see to believe. I was actually able to see hints of dust lanes in M31 and spiral structure in M82; my greatest thrills were a confirmed sighting of Pluto and the resolution of M13 into individual stars. I have been in amateur astronomy for 23 years and I have never used such an incredible telescope."*—**Michael D. Cloutier, Fair Haven, MI**

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*"While vacationing over the past week, I've had a chance to put the 8" LX200 through its paces. You've gone beyond the future and into sci-fi with this telescope. I want you to know that the LX200 has exceeded all my expectations, even better than my fondest dreams for a telescope of the future. Congratulations!"*—**Roger Ressmeyer, Sag Harbor, NY**

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*"Because Schmidt-Cassegrain quality has been a personal crusade on my part, I was champing at the bit to test the new Meade 10" LX200. I have always believed that building an excellent Schmidt was within the realm of possibility, and the new LX200 is a real winner. The optics are so good I am now having trouble understanding how you can produce them to the level you have and sell them so inexpensively. I have been "educated" by "optical experts" who said it can't be done. I now have proof that it is possible. Because I know a Schmidt's optics are complex, I always test them with a Ronchi eyepiece as well as real objects. The Ronchi tells if the surface curves are* ***accurate*** *and if the surfaces are* ***smooth.*** *Lack of smoothness will kill planetary detail by diffusing light into a hazy cloud around the planet. When I put the Ronchi on the Meade LX200 I couldn't believe what I saw! The bands produced by the Ronchi pattern indicated a surface as smooth as* ***any*** *refractor I have ever seen!! This level of smoothness is incredible in any reflective optical system. The Ronchi bands were also ruler-straight, indicating that the curves on the optics were right-on. No over- or undercorrection. Saturn was magnificent! The planet displayed more contrast and better colour rendition than any Schmidt I have ever owned—and I've owned 8 of them! The equatorial belt was markedly reddish-brown; the Cassini division was darker than I've ever seen it and I could easily see the Crepe ring thanks to the scope's high contrast. Views of deep-sky objects were excellent: M27, M57, and M13 all looked great despite light pollution at the site. The computer drive performed well. I quickly jumped from object to object and turned what was going to be a quick half-hour test into a very enjoyable* ***four-hour*** *observing session. There will be no trade-in of this instrument down the road, because you don't trade in perfection."*—**Richard Anderson, Mississauga, Ontario, Canada**

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*"At a star party in Austria last weekend I used an 8" LX200 for testing and observations. After hours and hours of using this instrument, it is clear the quantum leaps that Meade has made in telescope technology. Views of Saturn were startling! Planetary contrast and detail were simply unlike any 8" SC telescope that I had ever tested before! Stars were crisp and sharp. The more people looked, the faster word spread that something truly extraordinary was going on: Now people came with their testing tools and a Ronchi-grating confirmed the overwhelming impressions that everyone had during those observations. All lines were absolutely straight. Once the LX200's computer started to let the servomotors hum, the telescope attracted everyone on the observing grounds. I was scanning the heavens and soon people were standing in line to see NGC and Messier objects in rapid succession. Common exclamations were that here was a truly quality telescope that was a joy to use."*—**Stefan Thiele, Wiesbaden, Germany**

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*"The key word to describe my 10" LX200 is* versatile. *The LX200 is as simple or as sophisticated as my needs dictate. For casual observing I can quickly and accurately move from object to object. The superb optics and smoothness of the mounting make centering objects a visually exciting endeavor, not a fight. When I'm ready to use the technical sophistication of the LX200, the keypad handbox makes finding objects a matter of pushing a couple of buttons. I find that the LX200 makes technology work with me. I also have to mention the excellent support I have received from Meade. Any time I have called with a technical question, I have talked with a "live" person who is not only eager to answer my question but truly concerned with whether or not I am enjoying my scope. I find Meade's approach to business to be truly refreshing."*—**Steven L. Renshaw, Fresno, CA**

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*"I've owned 3 Schmidt-Cassegrains and a 12.5" Newtonian over the years, and recently at our club observatory, I used the most sophisticated commercially-available telescope I've ever seen, the Meade 10" LX200. I was impressed by the sharpness and contrast levels of the LX200. In light-polluted areas of New Jersey the use of a nebular filter is often required to enhance the contrast of deep-space objects, but when I saw the Crab Nebula (M1) clearly through the 10" LX200* ***without*** *a filter, I knew that the optics of the LX200 were obviously of the highest quality. As a result of this experience, I have ordered a Meade 10" LX200 for myself!"*—**John W. H. Simpson, Princeton, NJ**

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*"As an 8" LX200 owner, I am writing to tell you that I really love the instrument. In side-by-side testing against a friend's* [competing brand of] *8" SCT, to say the least there was no comparison. My Meade LX200 was light-years ahead in optical quality and technical capabilities. The LX200 is clearly the best Schmidt-Cassegrain in the world. Period."*—**Jinder Virdee, St. Thomas, Ontario, Canada**

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*"I recently purchased the Meade 10" LX200 and have been enjoying the scope immensely. You have produced a very high quality product and it has lived up to all my expectations and beyond. The LX200 makes astrophotgraphy a pleasure. The telescope's Smart Drive did a great job of assisting me in the 20-minute photo of M22, enclosed; it took very little effort as the telescope did basically all the work. You can bet I will highly recommend the LX200 to any amateur astronomer looking for a superb telescope."*—**Alfredo Garcia, Las Vegas, NV**

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*"Having just returned from two evenings of viewing on Mt. Pinos, I felt compelled to write you about my experience, as this was my first chance to really take my new 10" LX200 through its paces. What a wonderful combination of superb optics, rigid mounting, and accurate electronics!! I can't remember ever having spent a more enjoyable or productive evening observing! I emphasize 'observing' because that's what the LX200 allowed me to do. Having the telescope slew to my requested objects allowed me to enjoy viewing more objects than I ever thought possible. And speaking of viewing, what great optics! Amazing contrast, pinpoint star images. I have never seen as much detail in the cloud bands of Jupiter. I can't say enough about this scope. It was a breeze to set up (I was aligned, tracking, and observing in 5 minutes). The mounting is VERY solid. This telescope has an amazing array of features, outstanding optics and mounting. You've produced an outstanding product."*—**Charles Kuhn, Culver City, CA**

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**Shouldn't you be using the most advanced Schmidt-Cassegrain ever manufactured? Meade 8" and 10" LX200's are available for prompt shipment. Call or write your authorized Meade dealer today for full details.**

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# MEADE®

## 8" and 10" LX200's: the largest-selling serious telescopes in the world.

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| **8" LX200 Schmidt-Cassegrain** | **$2195.** |
| **Equatorial Wedge 8"** | **110.** |
| **10" LX200 Schmidt-Cassegrain** | **2495.** |
| **Superwedge 10"** | **395.** |
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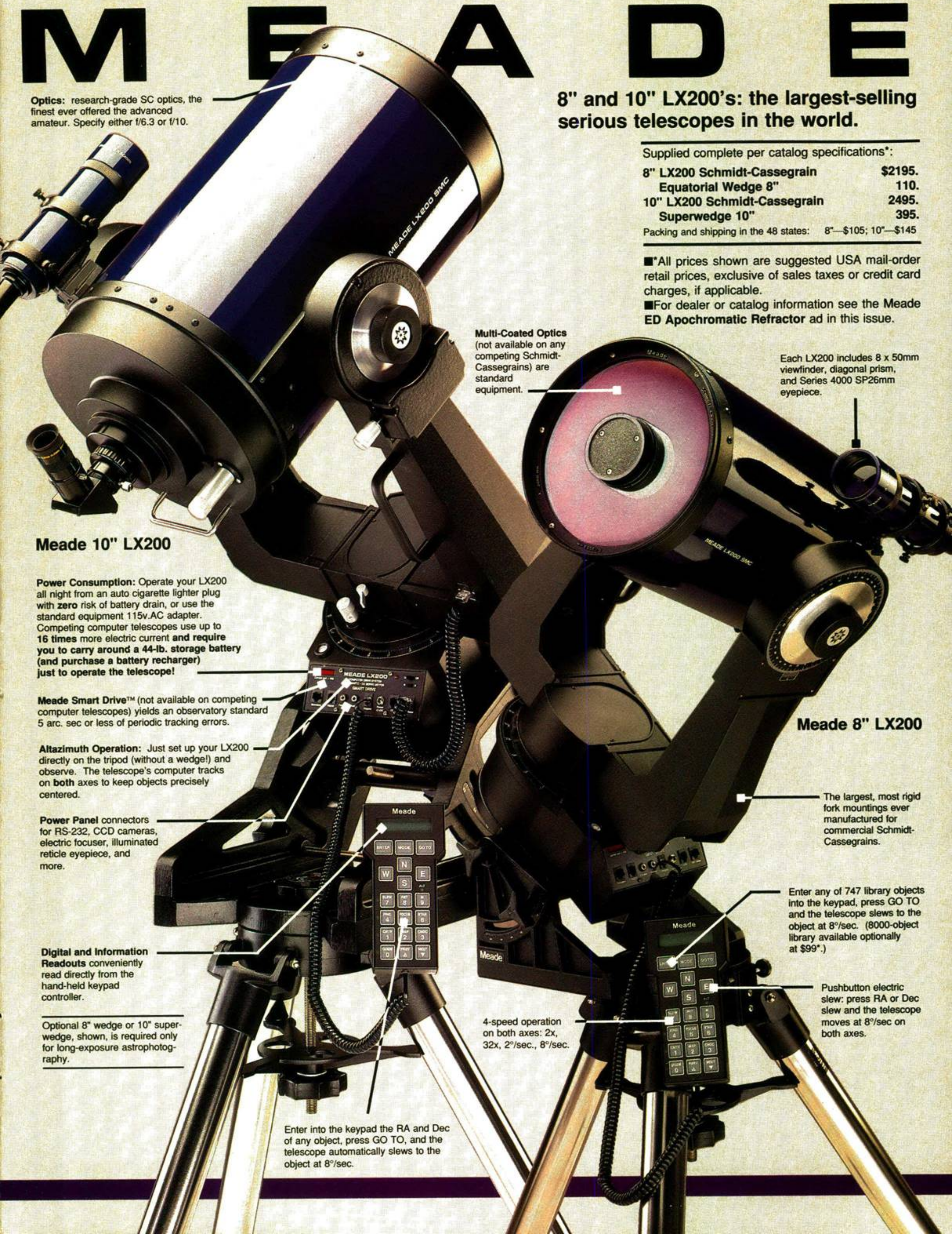
■For dealer or catalog information see the Meade **ED Apochromatic Refractor** ad in this issue.



**Optics:** research-grade SC optics, the finest ever offered the advanced amateur. Specify either f/6.3 or f/10.

**Multi-Coated Optics** (not available on any competing Schmidt-Cassegrains) are standard equipment.

Each LX200 includes 8 x 50mm viewfinder, diagonal prism, and Series 4000 SP26mm eyepiece.

### Meade 10" LX200

**Power Consumption:** Operate your LX200 all night from an auto cigarette lighter plug with **zero** risk of battery drain, or use the standard equipment 115v.AC adapter. Competing computer telescopes use up to **16 times** more electric current **and require you to carry around a 44-lb. storage battery (and purchase a battery recharger) just to operate the telescope!**

**Meade Smart Drive**™ (not available on competing computer telescopes) yields an observatory standard 5 arc. sec or less of periodic tracking errors.

**Altazimuth Operation:** Just set up your LX200 directly on the tripod (without a wedge!) and observe. The telescope's computer tracks on **both** axes to keep objects precisely centered.

**Power Panel** connectors for RS-232, CCD cameras, electric focuser, illuminated reticle eyepiece, and more.

**Digital and Information Readouts** conveniently read directly from the hand-held keypad controller.

Optional 8" wedge or 10" superwedge, shown, is required only for long-exposure astrophotography.

Enter into the keypad the RA and Dec of any object, press GO TO, and the telescope automatically slews to the object at 8°/sec.

### Meade 8" LX200

The largest, most rigid fork mountings ever manufactured for commercial Schmidt-Cassegrains.

Enter any of 747 library objects into the keypad, press GO TO and the telescope slews to the object at 8°/sec. (8000-object library available optionally at $99*.)

Pushbutton electric slew: press RA or Dec slew and the telescope moves at 8°/sec on both axes.

4-speed operation on both axes: 2x, 32x, 2°/sec., 8°/sec.

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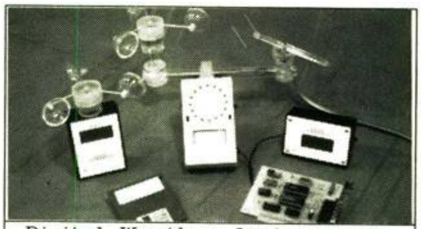

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*PC-Sky is like having a clear sky, binoculars, telescope, handbook, and time machine.*

**Clear Sky** Features super-fast plotting of naked-eye stars, fast panning, variable observing conditions, extinction, meteors, and local horizon.

**Binoculars** Features *all* stars to 7.5 mag, super-fast panning, bright clusters and nebulae.

**Telescope** Features accurate depictions of double stars, long-period binaries (with orbit diagrams), variable stars (with representative light curves), planets (with phases, rings, visible moons), and over 200 selected fields containing galaxies, clusters, nebulae, and stars to 16 mag. View time-step animations of eclipses, conjunctions, planetary satellites and binary stars. Simulates telescope apertures from 6 to 24 inches.

**Handbook** Features object descriptions and observing notes. Computes altitudes, azimuths, rising, setting, and transit times. Cross references star designations.

**Time Machine** Accurately depicts the sky for thousands of years into the past and future.

Requires PC-286/386/486, 640K, VGA, a 1.2 or 1.44 Mb floppy drive, and hard drive. Mouse recommended, but not required.

**Introductory Price $99** plus $5 s&h
(Offer good through December '92)

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*CapellaSoft*, PO Box 3964, La Mesa, CA 91944

of the telescope nicely balances both a Telrad and a 32mm Plössl eyepiece. — *Bryan Stone, Chelmsford, Massachusetts*

### Where Are the Mini-Black Holes?

With all the attention given lately to gamma-ray bursts (see "Bursting with Surprises," March 1992) I have heard little connecting them with black holes. Stephen Hawking has explained that virtual pairs of sub-atomic particles, one falling into a black hole and the other escaping, can lead to the explosion of the black hole. He has also shown us that a large number of primordial black holes should have formed shortly after the big bang and that these should be exploding today, giving off gamma rays. Is there any possibility that the gamma-ray bursts could be coming from primordial black holes? — *Sean Shields, Petaluma, California*

*— Gamma rays from exploding mini-black holes (if they exist) would not be as intense as the bursts of gamma rays seen by Compton.*

### Big Bang Puzzlements

The recent discoveries from the COBE satellite concerning minute variations in the background radiation (See "COBE's Big Bang" by Richard Talcott, August 1992) have brought to mind a question: If the background radiation we are seeing is from 300,000 years after the big bang and if the universe is 15 billion years old, then why has the light not already passed us? — *Ken Offer, Austin, Texas*

When we look into space we see left-over radiation in all directions. If the big bang occurred on an object the size of a basketball, why do we not see one large, bright point of light on the fringes of the universe? Indeed, can we determine where the big bang occurred? — *David M. Levy, Amherst, New York*

If the universe began with all the material in one spot, and a big bang occurred, all the material would be traveling outward from a center point. Where has this center point gone? Why is it that we see galaxies at tremendous distances in every direction, all receding from us? If light waves began traveling outward in all directions shortly after the big bang, what has happened to those light waves? — *Henry T. Swan, Holualoa, Hawaii*

I found Richard Talcott's article fascinating. However, the image on page 43 is supposed to indicate the variations in the microwave background. But the caption says the variations are of 0.01 percent and that instrument noise causes most of the patchiness shown. Elsewhere, the article states that the discovery team cannot point to any particular place in the sky and say this spot is hotter or colder than another, due to the "statistical nature of the analysis." What's happening here?— *Rod Glasgow, Santa Fe, New Mexico*

*— The big bang didn't start as a point. Rather, it was created everywhere at once. The cosmic background radiation visible in all directions reflects that the universe didn't form at just one point.*

*The signals observed by COBE are a combination of signals from the sky and instrumental noise. From the observed signals, the researchers subtracted the emission from our Galaxy and the effect of Earth's motion through space. The resulting sky map (shown in the August issue) is the sum of the cosmic background radiation, which includes the fluctuations and instrumental noise.*

*Unfortunately, the instrumental noise changes across the sky. To subtract out the effect of the noise, the research team had to average the noise over the entire sky. That left them with a statistical measure of the cosmic fluctuations, but they lost the point-by-point information.*

### Not Retrograde, Just Careless

On pages 28-29 of your October 1992 issue are three pictures of people. Astronomer Peter Backus and technician Luis Heredia are clearly identified. The third picture is of a woman standing beside the Multispectrum Analyzer. Who is she? — *Kathleen Hollingsworth, Laie, Hawaii*

*— She is Sally Page, software engineer for Sterling Software. Ms. Page is developing software for NASA's SETI project. Our apologies to her for not identifying her.*

### Corrections

*•Mr. Arild Mikalsen, the contributor of the aurora photo on page 88 of the September 1992 issue, resides in Mjøndalon, Sweden.*

*•In the special supplement* Buying Binoculars for Astronomy *(November issue), the Orion Telescope Center was omitted from the list of binocular manufacturers. Their number is (800) 447-1001. In California call (800) 443-1001.* ☐

## Viewpoints

# AN OBSERVATIONAL BREAKTHROUGH FOR ASTRONOMERS

*by Dean Grantham*

As a serious amateur astronomer, I often become frustrated by the limitations we face as we turn our telescopes to the evening sky. For instance, my home is near a large city and I live within the city's extended dome of light pollution. And although my small-aperture telescope (a trusty 4.5-inch Newtonian) struggles gamely to find the more exotic beasts that populate our Galaxy and beyond, its limited resolution and light-gathering capacity are no match for the light-years that separate me from my quarry.

They *were* no match, that is. Recently I developed a simple technique that has radically extended the range of my telescope and at the same time virtually eliminated every handicap amateur astronomers have had to work around.

My first success came with the object near Sagittarius A* at the galactic center, mentioned and pictured in ASTRONOMY's August 1991 AstroNews. I was able to view this object easily with my telescope despite the fact that the object had previously been detected only in the radio portion of the spectrum, and I actually captured greater detail than the Very Large Array Telescope in New Mexico was able to capture. But more about the enhanced detail later.

Here's how I did it. I placed my telescope in its usual spot in my driveway and inserted a low-power (35x) eyepiece. I then nailed the August 1991 issue to the wall of my neighbor's garage so that it faced my observing area. (*Be sure to turn to page 18 before nailing the magazine in place, to avoid frustrating delays in locating this faint object.*) I walked back to my telescope and in only 25 or 30 seconds had it in my field of view. And remember, this source is so faint it's almost off the end of the magnitude scale.

After observing for 10 minutes at low power, I switched to my 85x eyepiece. Magnificent! Subtle details not visible at low power sprang into view. My elation grew as I spent the next hour sketching the fine structure of this source, probably never observed before by human eyes. In all, I spent over an hour viewing Sagittarius A*'s companion, and I can tell you that I have never observed under such favorable conditions, despite my location just outside Philadelphia.

The ability to locate faint objects is only one of the advantages of this technique. Look over the following list of benefits, and I'm sure you'll soon become a devotee of my revolutionary new observing technique.

**Daytime observing**. Forget all those sleepless nights stumbling around in the dark, fumbling with unseen equipment.

**No star-hopping**. You no longer need to waste hours star-hopping across bright but boring stars on your way to that cute little number in Coma Berenices. I now do my star-hopping during TV commercials. A simple bookmark keeps hard-to-find objects waiting patiently for the next time I pull out my telescope.

**Image stability**. My new method actually eliminates the need for a clock drive. Objects remain centered in my field of view indefinitely. We were all tired of tripping over power cords and replacing batteries anyway.

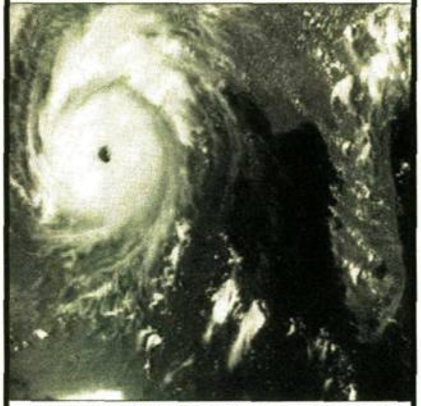
**Simplified star coordinates**. The new system I invented of Issue (Iss.) and Page Number (P.N.) is *much* simpler than the reviled system of right ascension (R.A.) and declination (Dec). It also puts to rest the long-smoldering dispute between the competing advocates of right ascension versus left ascension.

**Freedom from weather conditions**. Cloud cover won't inhibit your view at all. Even inclemency won't stop you. I tested this by observing M81 (Iss. May '91, P.N. 42) in a heavy downpour, and still had fair viewing, although there was some image bleed after the first 20 minutes. (Technical tip: when viewing in the rain with a Newtonian, avoid the hassle of having to drain water from your scope by nailing the object you're viewing to a position near the ground. This tilts the tube so drainage is automatic.)

**Solar observations**. Use your telescope to look directly at sunspots, solar flares, or the corona without special attachments and without any danger of damaging your eyes or your telescope.

**View all wavelengths**. I've already mentioned my success in viewing the radio source near Sagittarius A*. This observing technique works just as well for infrared, ultraviolet, and X-ray sources, and without the need for cumbersome filters.

**Recapture missed events**. The return of Halley's Comet sneaked up too



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**Enhance small-aperture instruments**. My 4.5-inch Newtonian actually has some advantages over much larger telescopes. A friend who owns a 17.5-inch Dobsonian has adopted my technique with excellent results, but he's encountered some problems with the technique that I have not. For instance, to focus on the X-ray source LMC X-1, the black hole candidate near the Tarantula Nebula (Iss. June '91, P.N. 42), he had to nail his copy of ASTRONOMY to the top of a telephone pole several blocks away, losing precious viewing time in the process.

Now back to Sagittarius A*'s companion. I discovered that this source is composed of an amazingly regular grainy pattern. There are dozens of smaller, regularly placed objects identifiable within the source. As I scanned the surrounding areas of reduced radiation, I saw that most of the dark areas were embedded with this same gridlike pattern as well. Realizing that I was seeing something never before reported in the literature, I tried to remain calm. I checked objects in several other issues and found that the gridlike structure underlies every star, galaxy, and planet in the universe.

This was a heady discovery to make with a 4.5-inch telescope! Frankly, I'm a bit surprised that it got past the fine folks at Palomar, but perhaps they'll take another stab at it now that they know what to look for. It didn't take long to assemble this wealth of information into a provocative new description of the universe, which is: *Everything in the universe is composed of a gridlike pattern of dots, which appear to radiate in only four wavelengths, corresponding to the colors cyan, magenta, yellow, and black.* (Now, I know a few of you will write in about the supposed fact that there's no such thing as a wavelength corresponding to black, but please don't do this, as even a first-year physics student knows about blackbody radiation. You can look it up.)

The black objects are particularly interesting — they seem to aggregate to form empty space — the more of them there are in a region, the emptier that region seems to be. One might say that interstellar space is "filled" with black holes! Can these black objects be the very black holes we have been seeking so long to confirm observationally? If so, their multitude would more than account for the missing dark matter of the universe. I never bought the brown-dwarf theory of dark matter anyway: first, brown is anything but dark, and when you think about it, how much could a brown dwarf weigh? Finally, I've never seen even one brown dwarf, and I get around a *lot*.

I am not aware of any current theories that can account for the four distinct classes of objects I've isolated, which are scattered throughout the universe and which seem to be the building blocks from which all astronomical objects are composed. I've tentatively labeled these objects C, M, Y, and K for the first letter of their signature color. (Please don't write to criticize my nomenclature. I'm the one who figured out all of this, so I get to make up the rules — that's the way real science works.) Thus, it appears that we live in a so-called CMYK universe, which I invite other astronomers to confirm observationally for themselves, using my new technique.

Well, there you have it — a great new technique to view virtually every known object in the heavens, a simplified astronomical coordinate system that can be mastered in seconds, and a succinct explanation of the underlying nature of the universe.

There are sure to be volumes devoted to expanding upon my watershed discoveries. Amateur astronomers everywhere can share the credit for my achievements, for this revolutionary new observing technique and the resulting new description of our universe was developed from within that community of serious-minded truth-seekers.

## EVENING STARS

*by S. Pat Hardage*

Al-nitak, Al-nilam, Mintaka . . . the names of the stars in Orion's belt are almost a litany. I recite them, my breath in steaming puffs before my face. Other names follow quickly — Betelgeuse,

*[continued on page 18]*

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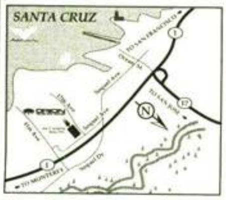

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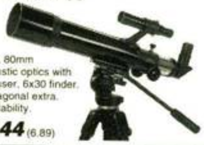

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# Filters

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Includes #21 Orange, #47 Violet, #11 Yellow-Green, #82A Very Pale Blue.
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**Schmidt-Cassegrain Broadband Filter**–fits rear cell of Meade & Celestron SC scopes.
#5658 **$79.95** (3.45)

**52mm Broadband Filter**–For 52mm camera lenses, adapter rings available for other diameters.
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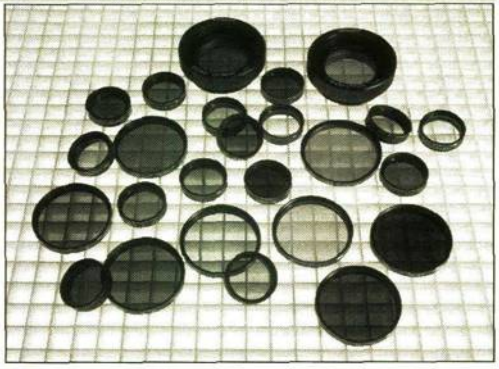

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Scope Saver

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***Ask about other sizes.***

## Deluxe Eyepiece Case

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Jim Bailey

Bellatrix, Rigel, and Saiph, the bright corners of the box that define the Hunter. The names proclaim the wonder and mystery of the winter sky.

For over thirty years I wanted to know the stars and the constellations by name. But I was always too busy to open a book or take a course to learn about more than the Dippers and Polaris. I sat back and watched Neil Armstrong on television as he walked on the Moon and viewed the later launches of the space shuttles. I read about the Mariner missions and how Voyager now travels beyond the orbit of Pluto. Then my son Austin was born.

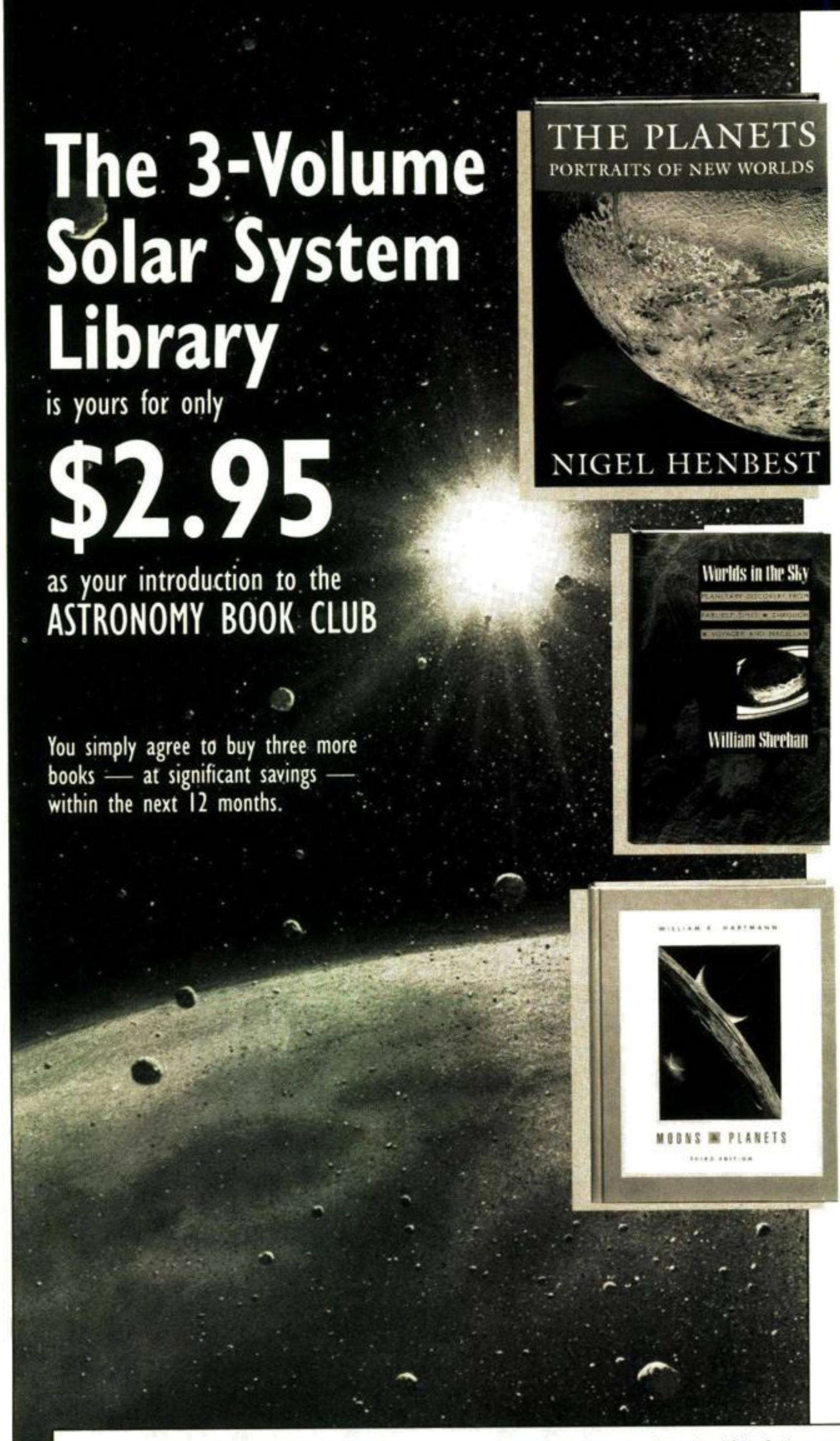
He likes to fall asleep while being rocked on my shoulder during a long walk through our dark, slumbering neighborhood — just Austin, me, the night wind, and the ever-silent stars. Sometimes Austin prefers to get toasty in his bunny suit, with his Grandma's patchwork quilt up around his ears and his feet tucked under a blue wool blanket. Then I load that bundle and a pillow into his wagon with the green wooden sides.

We walk together and talk together as only a parent and a one-year-old child can. We speak of many things: of trees and cats and barking dogs; of falling leaves and rain and snow; and of cars moving too fast and airplanes flying through the sky. We laugh together and bark at the Moon.

Through the seasons, we watch Mars march across constellations whose names I finally have time to learn. We watch bright Jupiter and lesser Saturn dance through the sky. We watch Venus climb and descend in the western sky. And we watch Mercury come and go more quickly. The meteor swarms of the deeper night so far have escaped Austin's sleeping sight. But his father has seen a few and kept the memory in a special place for a child who still sees and marvels.

No one knows how astronomy will affect Austin as he grows into a man. But the effect that astronomy has had on me is powerful, immediate, and unmistakable. What a great thing it is to be aware of nature on such a vastly grand scale. ☐

# Take A Fascinating Journey Through Our Solar System...



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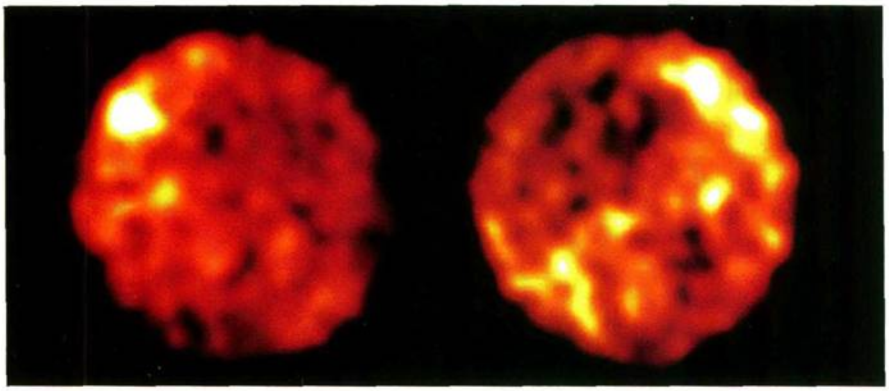
# HUBBLE OBSERVES IO



Francesco Paresce (ESA/STScI)

**IO'S SURFACE CHANGES** from bright to dark when you compare its appearance in visible light (left) with that in ultraviolet (right). Astronomers think that large areas of sulfur dioxide frost on Io's surface, which strongly absorb ultraviolet radiation, cause the difference.

Recent observations of Jupiter's innermost large moon, Io, paint a surprising picture of the volcanically active satellite. The observations, made with the Hubble Space Telescope, show that Io's atmosphere is smaller than previously thought, confirm that its surface is covered with patches of sulfur dioxide frost, and reveal that few if any major changes have taken place since the Voyager encounters.

A team of astronomers from the Space Telescope Science Institute, the University of Michigan, and Johns Hopkins University used HST's Faint Object Spectrograph to study sulfur and oxygen emissions from Io's atmosphere. They found that the atmosphere extended only 1.5 Io diameters across, compared with previous estimates of up to 5 Io diameters.

The observations also show that the atmosphere may be patchy, with some regions being one thousand times denser than adjoining regions. The sources of the atmosphere appear to be sulfur dioxide erupting from the volcanos, evaporation of surface frost in sunlit areas, and material knocked off the surface by high-energy particles in Jupiter's magnetosphere.

Francesco Paresce of the European Space Agency and the Space Telescope Science Institute led a group of astronomers who used the Faint Object Camera to study the surface of Io. They took both ultraviolet and visible light images and found marked differences between the two. Regions that look bright in the visible appear dark in the ultraviolet. The team believes they are seeing an effect first seen by Voyager — large areas on the satellite's surface covered with sulfur dioxide frost, which absorbs strongly in the ultraviolet but reflects quite well in the visible.

Paresce's team also looked for changes on Io's surface. HST is the only telescope that can resolve detail well enough to track such changes. Hubble resolves the surface of Io about as well as the human eye resolves the lunar surface, even though Io is 2,000 times farther away than the Moon.

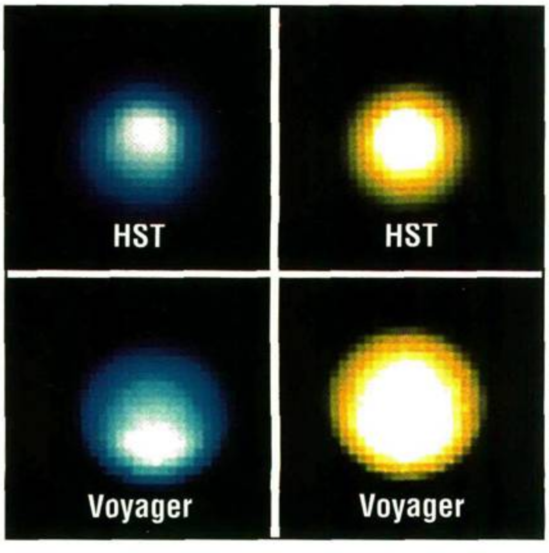
The researchers took Voyager images of Io, which have much higher resolution still, and purposely blurred them to match HST's resolution. They found that at this resolution, even the more volcanically active hemisphere of Io has not changed noticeably in the 13 years since the Voyager encounters. They are still analyzing the images, however, looking for more subtle changes.

The lack of change is puzzling because Io's intense volcanism should resurface the satellite at a rate of a few inches' thickness per year. One possibility is that some process removes or covers the volcanic debris at the same rate as fresh deposits are laid down. In any case, the astronomers plan to continue observing this dynamic and evolving satellite.

## SEASONAL CHANGE OBSERVED ON TITAN

Images of Titan taken 9 years apart show Saturn's largest satellite experiences seasonal change. The images taken by the Hubble Space Telescope and the Voyager 2 spacecraft were studied by John Caldwell and his colleagues of the Institute for Space and Terrestrial Science in Concord, Ontario. Hubble images taken on August 26, 1990, show the northern hemisphere was 10 percent brighter than the southern hemisphere. Voyager images taken August 21, 1981, show the southern hemisphere as brighter.

The brightness changes in both the blue images taken at 439 nanometers and yellow images, taken at 547 nanometers, indicate that chemical reactions in the atmosphere do not cause the changes. The seasonal change also seems to follow behind heating by the Sun by one-quarter of Saturn's orbit about the Sun, or about 7.4 years. Earth's seasons also lag solar heating by a fraction of its orbital period — one-sixth of its orbit or two months. When Titan appeared brightest in the southern hemisphere, both hemispheres of the satellite received equal amounts of sunlight. In 1987 when scientists expected the satellite to have uniform brightness, Titan's north pole pointed toward the Sun. Future Hubble images will permit continued monitoring of Titan's seasons and additional testing of the seasonal model.



John Caldwell, Institute for Space and Terrestrial Science

**BRIGHTNESS CHANGES ON TITAN** indicate it has experienced seasonal change in the years between Hubble's view of the satellite in 1990 (top photos) and Voyager 2's visit to Saturn in 1981 (bottom photos).

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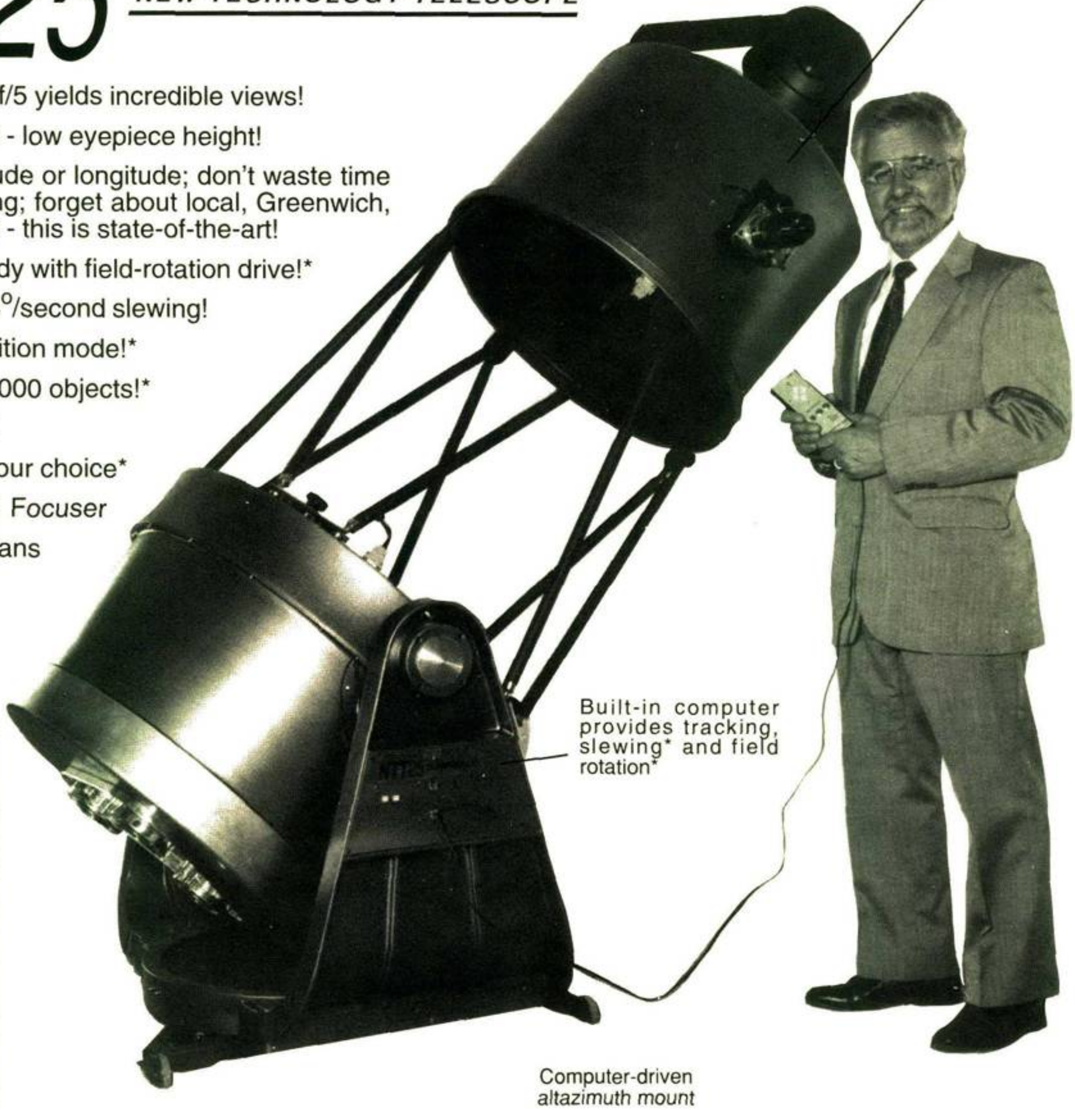

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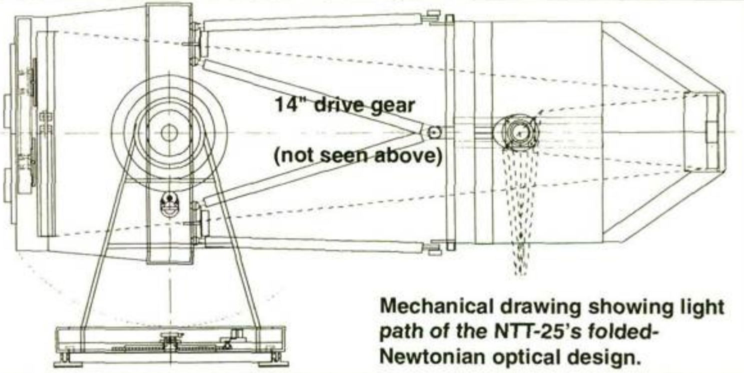

**Mechanical drawing showing light path of the *NTT-25's folded*-Newtonian optical design.**

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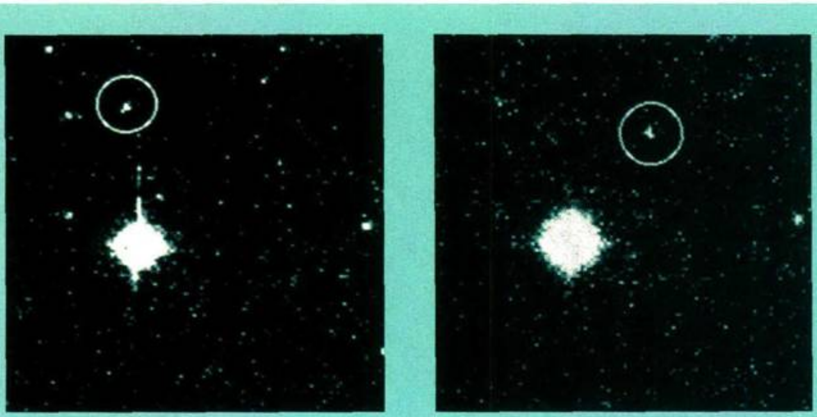


European Southern Observatory

**THE MOST DISTANT OBJECT** known in the solar system appears to be the newly discovered miniplanet designated 1992 $QB_1$. (See "A New Member of the Family," December 1992.) Astronomers confirmed its great distance — some 41 astronomical units from the Sun — with follow-up observations in late September. In these images taken 4 hours apart on September 27, you can see 1992 $QB_1$ moving against the starry background of Pisces.

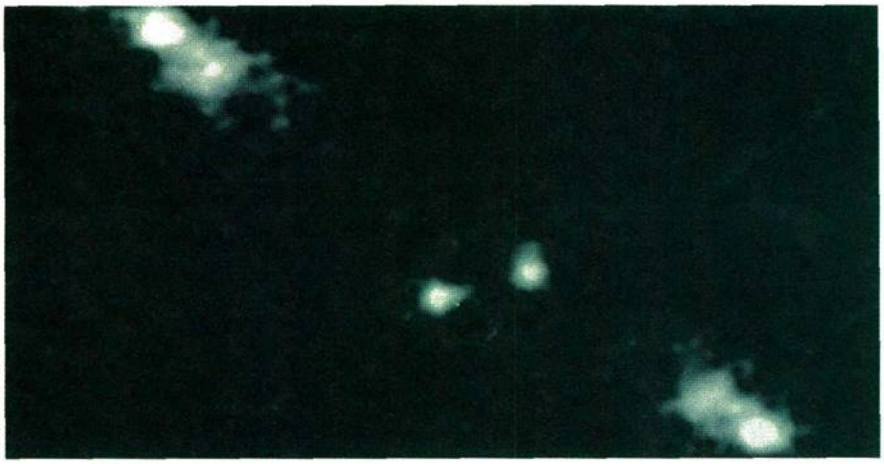
## *GRAVITY LENS PROBES THE UNIVERSE*

When astronomers recently pointed the Hubble Space Telescope (HST) at a distant cluster of galaxies, they found two strikingly similar galaxies. They discovered, however, that the light was not coming from two separate galaxies. Instead, it was coming from a single, distant galaxy. The light from this galaxy was being split into two images by the intervening cluster, which acts as a distorting lens. The finding is helping researchers map the extent of dark matter in the cluster.

The image of the distant galaxy splits apart because the great mass in the galaxy cluster gives the cluster a significant gravitational field. Light bends as it passes through this powerful field. In this case, the light from the distant galaxy divides into two images, each of which appears brighter and larger than it would otherwise.

Richard Ellis of Durham University in England and his colleagues found the gravitational lens while observing the galaxy cluster AC 114, located 4 billion light-years away. Their 6-hour exposure with HST's Wide Field Camera showed the striking pair of faint objects near the center of the cluster. Structures visible in each image showed perfect mirror-symmetry and identical colors. The images are separated in the sky by 10 arcseconds, giving them the greatest separation of any object we see through a gravitational lens.

The two images provide astronomers with a powerful probe of the galaxy cluster's gravitational field and thus the distribution of dark matter within the cluster. Astronomers estimate that up to 95 percent of the universe consists of matter that doesn't emit radiation that can be detected. But dark matter exerts gravity, so we can infer its existence from its gravitational influence. By studying the strength of this gravitational lens, astronomers estimate that AC 114 contains about ten times as much dark matter as it does visible matter and that the dark matter is concentrated toward the cluster's center. By using HST to look at similar systems in other clusters, Ellis hopes to probe the changing structure of galaxy clusters as they evolve and grow.



Richard Ellis/NASA

**MIRROR IMAGE GALAXIES** turned out to be a single galaxy gravitationally lensed to appear double. The gravity of the distant galaxy cluster AC 114 (two of whose galaxies appear at the center of the image) bends the light of an even more-distant galaxy into two images separated by 10". The finding will help astronomers map the extent of dark matter in the cluster.

## *HOT STARS AND MORE*

The first-ever survey of the sky at extreme ultraviolet wavelengths has uncovered hundreds of extraordinarily hot stars in the Galaxy and adds weight to previous measurements that suggested a large cloud of dense gas lies near the Sun.

The findings came from the Wide Field Camera (WFC) on board the ROSAT satellite, a joint project of the United States, United Kingdom, and Germany. The WFC is the British component of the mission and is designed to map the entire sky in the extreme ultraviolet — those with wavelengths falling between ultraviolet and X rays — the last unexplored part of the electromagnetic spectrum.

The camera catalogued 384 cosmic sources, including one star with a temperature of at least 170,000 K. Many of the bright sources found by the WFC were hot white dwarfs and active stars. The white dwarfs — remnants of stars like the Sun that have exhausted their nuclear fuel — radiate in the extreme ultraviolet because of surface temperatures as high as 100,000 K. The active stars produce extreme ultraviolet emission from their strong magnetic fields.

But perhaps of greatest interest is the

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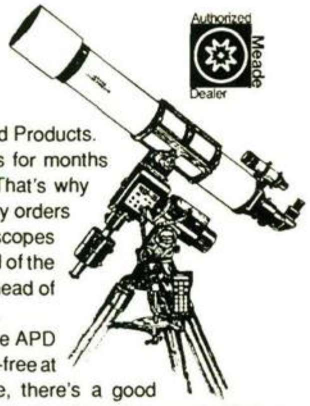

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finding that the distribution of extreme ultraviolet sources across the sky is not uniform. Relatively few sources were seen in the direction toward the center of the Galaxy. The WFC scientists think this patchiness is caused by a dense cloud of interstellar hydrogen and helium that lies about 50 to 200 light-years from Earth.

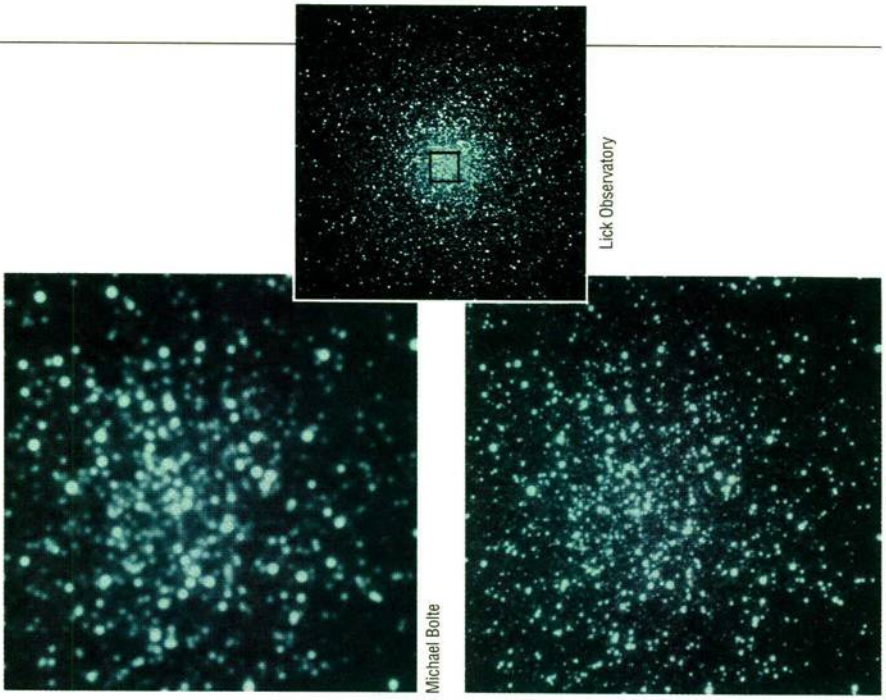
## *GEMINGA GAMMA-RAY SOURCE IS A NEUTRON STAR*

Geminga, a gamma-ray source in the constellation Gemini, has long confused astronomers as to its true identity. First observed by the SAS-2 satellite in 1973, Geminga's position does not correspond with any known pulsar, bright X-ray emitting binary, or quasar. Yet this object emits over 1,000 times more energy in gamma rays than in X rays and 1,000 times more energy in X rays than in visible light. D. L. Bertsch of NASA's Goddard Space Flight Center and his co-investigators recently found that Geminga emits pulsed gamma rays with a period of 237 milliseconds.

Using the EGRET telescope on board the orbiting Compton Gamma Ray Observatory, they observed that the period changed over a two-month interval. The change in period is consistent with the change expected in the spin rate of a 300,000-year-old neutron star. Geminga's gamma-ray brightness suggests that it's no more than 1,250 light-years away.

## *FIRST KECK II MIRROR DELIVERED*

Keck II, the second 10-meter telescope being built on the island of Hawaii, received the first of 36 mirror segments on August 24, 1992. Production of the mirror segments for Keck II has proceeded quickly. Germany's Schott Glassworks has delivered 21 of 42 segments (36 for the mirror and 6 spares) to Itek Optical Systems and Tinsley Laboratories, the companies figuring the mirrors. By August, 16 of the segments were already polished and 4 were figured by Eastman Kodak with a new technique called ion figuring. (See "Seeing a Brave New World" in the August 1992 ASTRONOMY for information about ion figuring.) The Keck I mirror segments will undergo ion figuring as well, improving the already high image quality of the scope.


Lick Observatory

Michael Bolte

Michael Bolte, University of California, Santa Cruz

**ASTRONOMERS OBSERVED THE CENTER OF M3**, a globular cluster in the constellation Canes Venatici, using the High Resolution Camera (HRCam) on the Canada-France-Hawaii Telescope located on Mauna Kea in Hawaii. The image at top shows the region of the cluster observed by the astronomers (shown roughly by the box). Normally, turbulence in Earth's atmosphere makes a telescope's image move slightly, blurring the image as shown in the photo at left. The HRCam compensates for this image motion, yielding sharper images of the stars in the cluster and revealing many faint stars in the cluster's center (image at right). Robert McClure and René Racine of Canada's Dominion Astrophysical Observatory built the camera.

Michael Bolte of the University of California, Santa Cruz, and James Hesser of the Dominion Astrophysical Observatory took the HRCam images of M3 to look for "blue straggler" stars. These stars appear brighter and bluer than other stars with the same age in the cluster. Researchers believe that blue stragglers may form in binary star systems in which one star loses mass to the other. The star that receives mass heats up from the extra mass and becomes brighter and bluer. Finding how many blue stragglers occur at the center of globular clusters will help astronomers understand how binaries evolve in clusters and how often stars collide in a cluster's dense central region.

## Space News

# *NEXT STOP MARS!*

On August 24, 1993, Mars Observer will become the first American spacecraft to arrive at the Red Planet in 17 years. From a polar orbit 250 miles above Mars, the spacecraft will map the planet's surface and monitor changes in its weather over a full Martian year (687 Earth days).

But getting started on the 450-million-mile voyage wasn't easy. Four days after the probe arrived at the launch pad, technicians discovered debris contaminating the craft. During last-minute preparations to protect the spacecraft from Hurricane Andrew, debris entered a nitrogen line designed to keep the spacecraft in a clean environment. Cleaning up the spacecraft delayed the launch nine days. But on September 25, the Titan 3 rocket lifted off launch pad 40 at

Sean Sullivan

**MARS OBSERVER** rocketed on its way to Mars on September 25. It will reach the Red Planet 11 months later.

# 550 BC: Anaximander invents the star chart.

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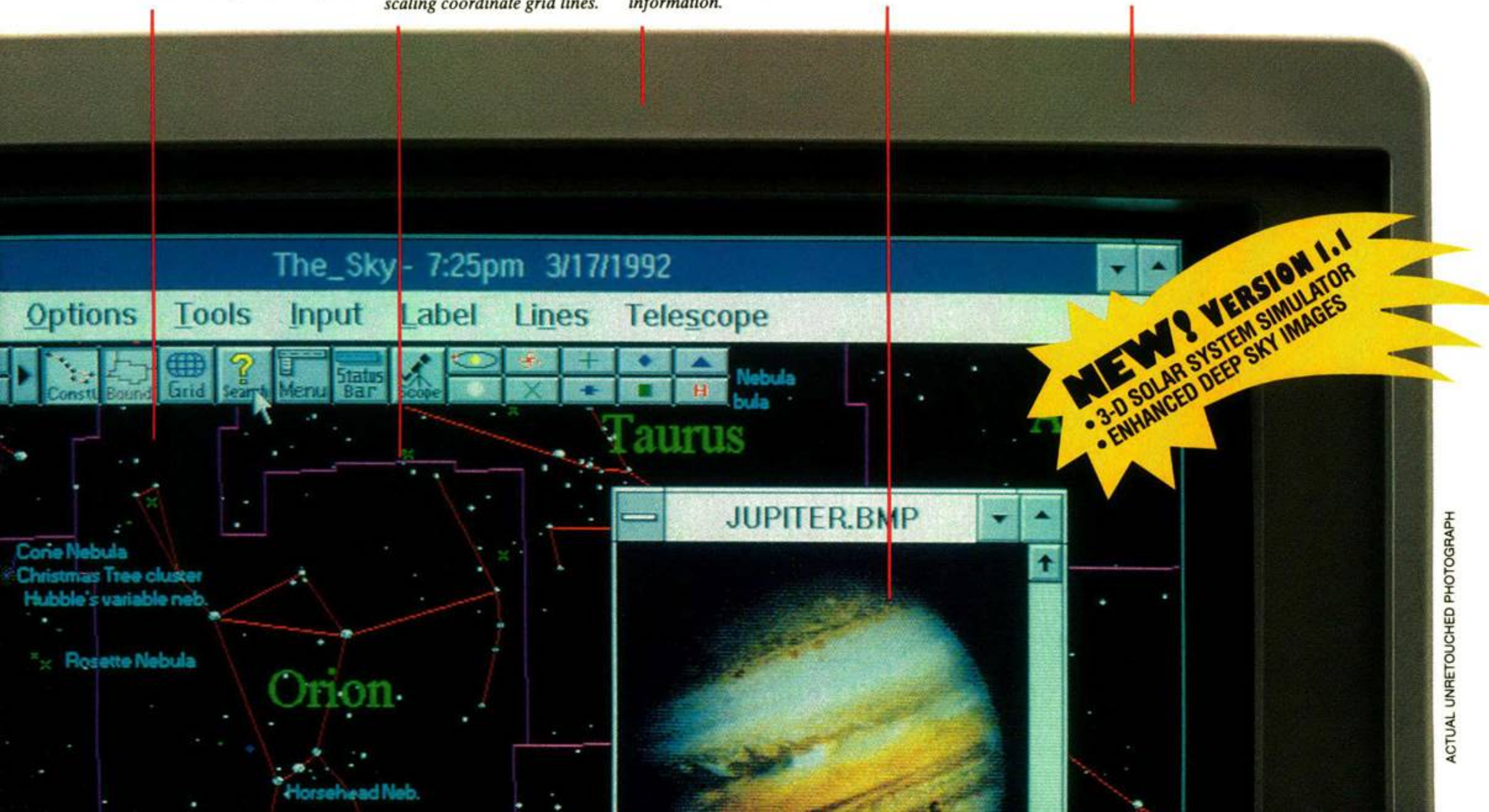

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ACTUAL UNRETOUCHED PHOTOGRAPH

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Cape Canaveral, carrying Mars Observer into Earth orbit.

Shortly after reaching orbit, an upper stage called the Transfer Orbit Stage (TOS) fired to propel the probe toward Mars. This was the first flight of a TOS — and the new booster gave mission planners a scare when it failed to send any signals back about its health or whether it had even fired.

The crew of a tracking aircraft over the Indian Ocean reported seeing a flash of light when the TOS was supposed to have ignited. A tense hour of radio silence was finally broken when signals from the Mars Observer craft indicated that it had separated from the TOS in good health and was on its way to Mars. The upper stage had worked fine, but a failed radio transmitter on the TOS (Mars Observer's radios were fine) had prevented it from sending word of its performance back to Earth.

In the days following launch, Mars Observer extended its high-gain antenna, solar panels, and two booms containing science instruments. On the way to Mars, one instrument, the Gamma Ray Spectrometer, will watch for bursts of gamma rays coming from distant sources in the Milky Way and beyond. The other instruments will remain inactive until the craft arrives at Mars later this year. (See September 1992 ASTRONOMY for more details on the mission.) — *Sean Sullivan*

## ONE DOWN . . .

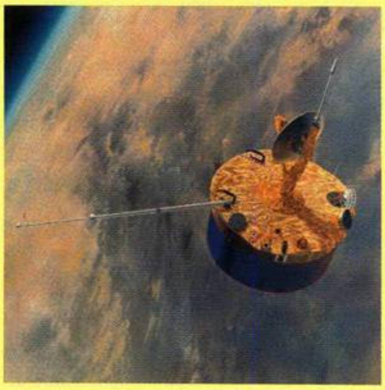
Although the Magellan probe has garnered all the Venus-related attention in the last two years, Pioneer Venus has continued to circle Venus, its ongoing mission largely forgotten. Until October 8, 1992, that is. On that day, with its propellant fuel exhausted, Pioneer plunged into the dense clouds of Venus, burning up like a meteor.

Pioneer Venus, also known as Pioneer 12, had explored Venus since 1978. Among its achievements were the first global maps of the planet's cloud-covered surface and movies of its swirling cloud patterns. Originally designed to work for one Venus day (243 Earth days), Pioneer ended up lasting 5,226 days — over 14 years.

"We last heard from the spacecraft just before its orbit carried it behind Venus," says Richard Fimmel, Missions Manager at NASA's Ames Research Center. "When Pioneer should have reappeared, there was no signal. We knew we no longer had a spacecraft."

Many of the mission scientists gathered at Ames for Pioneer's final hours. "We were all a little sad at the loss of an old friend," Fimmel relates, "a friend we had worked with daily for 14 years. But throughout its lifetime, Pioneer had been so productive scientifically that we had cause for great celebration."

True to form, the venerable spacecraft continued to send back information right up to the end. In its final days, Pioneer was skimming only 79 miles above the planet's surface, allowing its instruments to search for signs of lightning and evidence for Venus' long-lost oceans.


NASA/Paul Hudson

**PIONEER VENUS ORBITER** spent 14 years circling Venus. Its mission came to a fiery end on October 8, 1992.

## . . . BUT ANOTHER STILL GOING

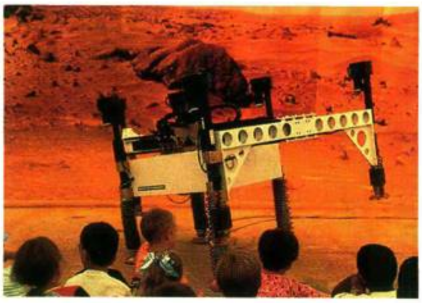
The day after Pioneer Venus met its demise, another spacecraft from the same era demonstrated its longevity when Voyager 1 passed the 50 AU mark on its trek outward from the Sun. Fifty AUs is 50 times the average distance from Earth to the Sun, placing Voyager over 4.6 billion miles from the Sun. The space probe is now traveling at 320 million miles per year heading toward the stars an angle of 35° above the plane of the solar system.

Voyager 1 was launched in 1977 and flew past Jupiter in 1979 and Saturn in 1980. Both it and its twin, Voyager 2, are still operating. Scientists hope that both will continue to function as they pass the heliopause, the boundary between the Sun's environment and interstellar space, thought to lie 60 to 90 AUs out.

## ROVERS ON THE LOOSE

Some rolled, some walked, one floated, and one somersaulted over obstacles. In all, 16 robots from around the world performed for thousands of spectators on the Mall in Washington, D.C. The event was the Planetary Rover Expo held September 1 and 2. Organized by the National Air and Space Museum, the Planetary Society, and NASA, the expo was the largest gathering of robotic vehicles designed to explore other worlds.

"The idea of the exhibit was to bring the excitement of what is possible with planetary exploration to the public," commented Susan Lendroth of the Planetary Society. And the public responded. During the two-day event an estimated 8,500 people turned out to see the robots perform on a simulated Martian terrain. — *Jay Mallin*



**BEAM WALKER** from Martin Marietta walks on 7 legs.

Both photos by Jay Mallin

**GO-FOR** is a micro-rover built by JPL.

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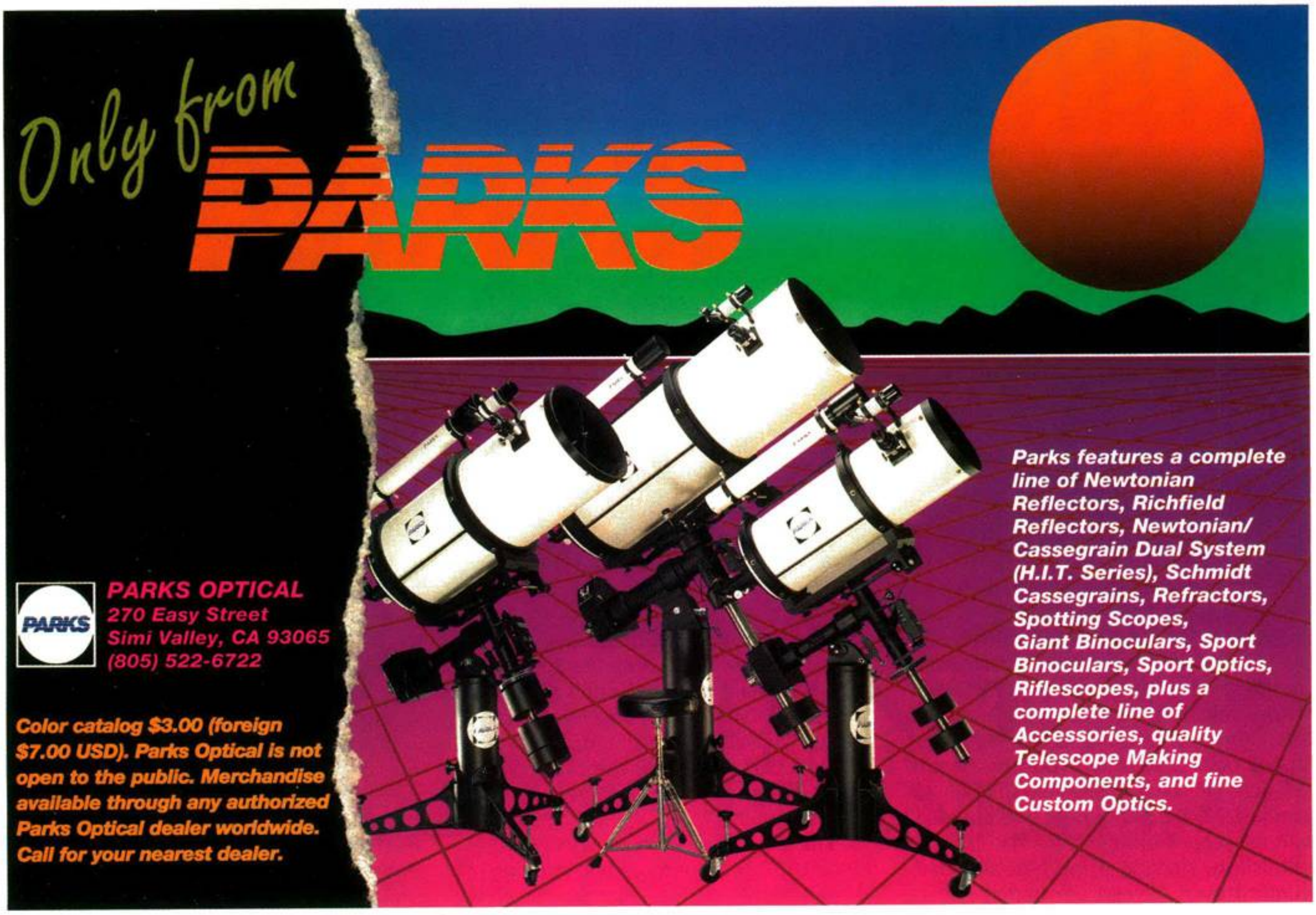

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**Amateur News**

# STAR PARTIES COAST TO COAST

### The Northwest: Table Mountain Star Party

The aftermath of any star party involves a groggy recovery period for party goers. It's worse if the star party is favored by three nights of starry, Milky Way-filled skies. That was certainly the case at the 1992 Table Mountain Star Party, held July 31 to August 2. This combination star party/convention is held high in the Cascade Mountain Range of Washington state and is coordinated by the various societies of the Northwest Region of the Astronomical League. The get-together attracted over 500 amateurs and enough telescopes to cover the mountaintop. Out of the more than 200 Dobsonians, equatorial Newtonians, refractors, and bino-chairs at the 1992 gathering, a couple of scopes beg a closer look.

Fred Phillips of the Seattle Astronomical Society demonstrated how his 12.5-inch Newtonian telescope sets up in a couple of minutes. To pack it away, the split-ring mount folds up with a "flip flip flip" and becomes virtually flat. The scope picked up the Most Innovative Design Award.

With telescopes, bigger is often better but only if the mount is steady and the optics sharp. The 400-pound 33.4-inch Dobsonian, nicknamed "the Beast," built by Mike Benz with help from Dan Bakken and other members of the Spokane Astronomical Society passes both tests. The Table Mountain judges gave this one a merit award for Optical Excellence.

Overall, the Table Mountain Star Party has become a major event. If you have never toured the great northwest, consider attending Table Mountain next year. For more information write to TMSP, c/o Spokane Astronomical Society, P.O. Box 8114, Spokane, WA 99203. — *Brad Snowder*

### The Midwest: Astrofest

Since its inception in 1979, Astrofest has evolved into one of the continent's finest festivals of telescopes and amateur astronomy. Regulars at the star party commented on how not so long ago telescopes occupied *only* a portion of the 130-acre site near Kankakee, Illinois. At Astrofest 92, the entire field was covered with telescopes brought by a record 570 enthusiasts, making it the best-attended Astrofest ever. "When we started Astrofest," commented Alan Birkner of the Chicago Astronomical Society, "our idea was to give the midwest amateur astronomers a place of their own. The West Coast had Riverside and the East Coast had Stellafane. Fewer than 100 people attended the early Astrofests. Now we have trouble accommodating everyone!"

Each year, backyard astronomers bring telescopes of every make and variety. If it focuses light from the sky, chances are you'll see an example of it at Astrofest. And while commercially made telescopes populate the field in abundance, the most unusual scopes are the homemade models.

This year one of the hand-crafted highlights was brought by Craig Engelhorn from Naperville, Illinois. His 6-inch f/10 reflector features a primary mirror that is tilted at an angle. It bounces the light up to an elliptical diagonal mirror mounted at the top of the tube but off to one side. The diagonal then reflects the light to an eyepiece on the opposite side of the tube. Unlike a conventional Newtonian reflector, this "tilted-component" design lacks a central obstruction in the light path, boosting contrast and resolution.

Another center of attraction was Jon Slaton's impeccably finished 6-inch f/15 refractor made by Alvan Clark and Sons in 1920. Jon spent 2 years restoring the classic telescope. The result is a telescope as magnificent to look at as it is to look through.

The 1993 Astrofest will be September 10-11. For information contact the Chicago Astronomical Society, P.O. Box 596, Tinley Park, IL 60477.

### The East Coast: StarConn

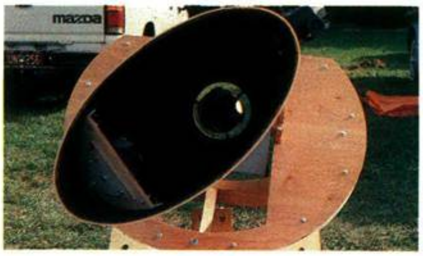
Great amateur get-togethers don't always need dark skies. The Astronomical Society of Greater Hartford, organizers of the annual StarConn in Connecticut, time their event to keep it away from the New Moon. "We let Stellafane and other events provide the star parties," explains Suzanne Marinan, StarConn's principal organizer. "We try to concentrate on an indoor show. Holding StarConn when the Moon is in the sky means amateurs don't have to sacrifice any observing nights to attend."

The logic has worked very well — since 1987, StarConn has become one of the highlights on the calendars of New England amateur astronomers. "Our goal has always been to create a program that the general public could attend and come away from feeling they really learned something," adds Jay Sottolano, one of the meeting's founders. "But because of the economy, we had expected a down year for attendance in 1992. Instead the attendance was as high as it's ever been." About 250 people filled the lecture hall to hear talks about discovering black holes, mapping galaxies, and creating color images with the latest amateur CCD cameras.

Surrounding the lecture hall, a dozen national and local area astronomy dealers set up tables filled with merchandise. Conference-goers could take advantage of bargains on eyepieces, filters, books, computer software, T-shirts, and even meteorites.

This year StarConn is tentatively set for spring. For information about attending or exhibiting, contact the Astronomical Society of Greater Hartford, c/o Suzanne Marinan, 367 Sugar Hill Road, Tolland, CT 06084. ☐

**THE CLASSIC CRAFTMANSHIP** of an Alvan Clark telescope shines in Jon Slaton's restored refractor displayed at AstroFest '92.



**A UNIQUE TELESCOPE**, brought to AstroFest by Craig Englehorn, uses an off-center diagonal mirror and a tilted primary.

ASTRONOMY: photos by Alan Dyer

**WATCHING SOLAR PROMINENCES** with a filtered telescope was a popular attraction at StarConn 92.

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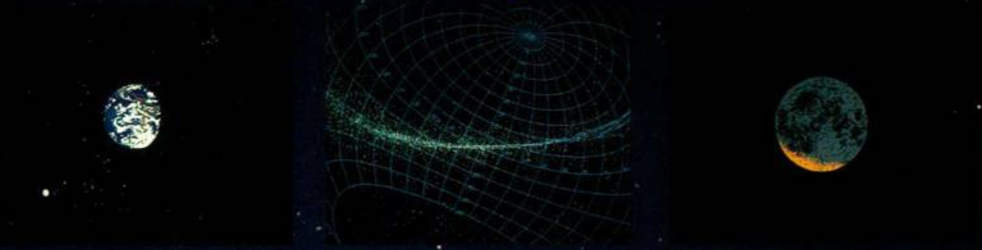

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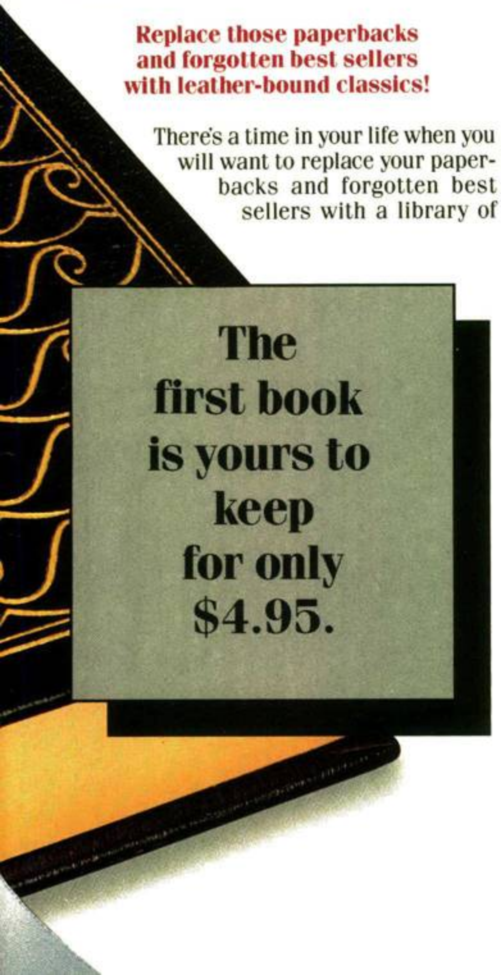

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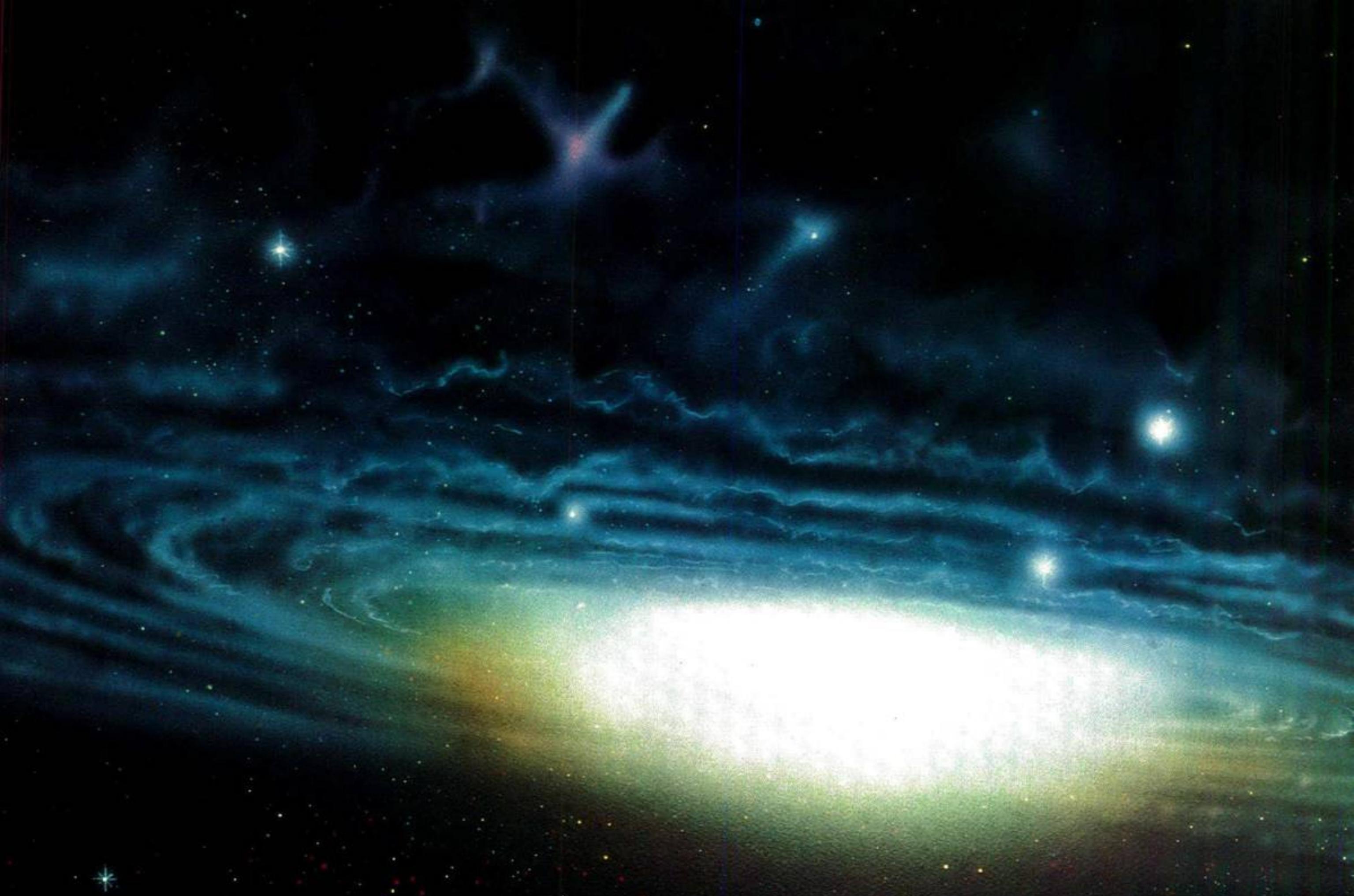
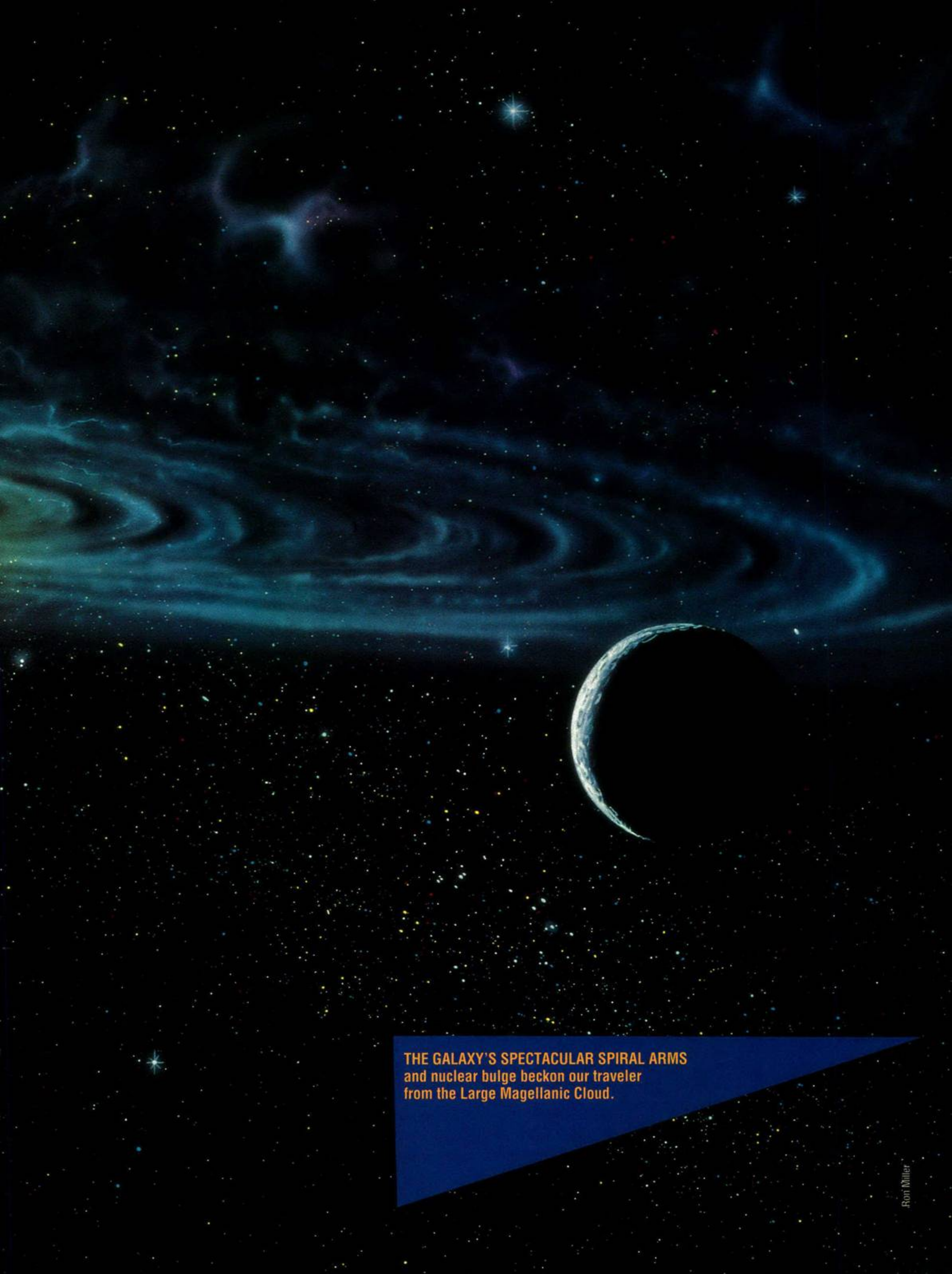


COSMIC ADVENTURES

# JOURNEY into the GALAXY

Embark on a breathtaking tour of the Milky Way Galaxy — from the sparse outer halo to the dense and mysterious core.

by Gerrit L. Verschuur



**THE GALAXY'S SPECTACULAR SPIRAL ARMS** and nuclear bulge beckon our traveler from the Large Magellanic Cloud.

Ron Miller

On a clear night from Earth's Southern Hemisphere, our Galaxy's nearest neighbor looms big and bright. Spanning some 10° and shining with the combined light of billions of stars, the Large Magellanic Cloud greets southern observers across a distance of 165,000 light-years.

As impressive as our view of this galactic neighbor is, however, imagine how spectacular our Milky Way Galaxy must appear from a planet in the Large Magellanic Cloud. Stretching one-third of the way across the sky, our Galaxy's vast sweep softly illuminates the alien planet's surface with the diffuse glow from several hundred billion stars.

Suspended in the sky, the Galaxy appears as a huge swirl of luminous matter interlaced with long streaks of darkness that spiral out from a central bulge. The ribbons of bright interstellar gas and dark dust lanes outline spiral arms, which are richly laden with bright young stars. From your home on the alien planet, you begin to wonder what it would be like to travel to this Galaxy, to journey along its thin, ponderously rotating disk and then cruise into the bulge, which glows in fiery brilliance at the hub of the spectacle that dominates your night sky.

On your journey, you travel through space unhampered by the cosmic speed limit — the speed of light. You are free to scan the entire spectrum of electromagnetic radiation that permeates space. You sense the soft touch of radio waves and the warm glow of infrared radiation. You take in the vivid rainbow of visible light and the harsh blast of ultraviolet. And you feel the tingle of X rays and the prickle of gamma rays as they pass through your body.

### The Adventure Begins

You take off, quickly accelerating to a thousand times the speed of light. A quick calculation tells you it will take nearly 200 years to reach the Galaxy. That's far too slow, so you accelerate once more, increasing your speed a thousandfold.

In the distance you see a number of bright, yellow-orange points of light. As you magnify the view, these objects resolve into myriad individual stars. Galaxy residents call these objects globular clusters. More than a hundred such clusters, each a nest of up to a million stars, drift lazily about the center of the Milky Way. The sentinels of the Galaxy, globular clusters are relics of the distant past, born when the universe was still young.

Three weeks into your journey and about 100,000 light-years from your destination, you pause to take stock of your environs. Ahead lies the splendor of the Milky Way Galaxy. Behind you, the Large Magellanic Cloud appears only slightly less splendid. And to all sides you see darkness, interrupted occasionally by pinpoints of light signifying the presence of distant globular clusters and faint, nearby stars.

The presence of the faint stars is surprising because, from a distance, the grandeur of the Galaxy's much brighter nucleus and spiral arms overwhelms them. Along with the globular clusters, these stars reside in an immense spherical halo that extends more than 100,000 light-years from the center of the Milky Way Galaxy. Like the stars in globular clusters, the halo stars formed at the same time as the Galaxy and thus represent the Galaxy's oldest population of stars.

Except for these isolated points of light, the darkness all around seems absolute. But as you start scanning this void with all senses, you notice a profusion of tiny particles hurrying by. These particles form the building blocks of the universe — the protons and electrons that make up all atoms. Some travel at near the speed of light; others drift by seemingly at a snail's pace — yet even these move 10 kilometers every second. Only about one particle exists in every thousand cubic centimeters of emptiness, but as the protons and electrons pass each other in the dark, they radiate a little of their energy and fill the void with a diffuse haze of ghostly emanations.

**A BRIGHT KNOT OF NEBULOSITY attracts our visitor's attention to a spiral arm halfway from the Galaxy's center to its edge.**

Now notice something else. The glow from the Milky Way has warmed the diffuse material in the Galaxy's halo to a million degrees. Though far too rarefied for you to feel any heat, the gas radiates very faintly in X rays.

Another electron speeds by at near the speed of light. Its journey began eons ago in a dying star, but today magnetic fields in the Galaxy control its destiny. The fields continually push and pull the charged particle, forcing it to change course and in the process radiate radio waves. The action of the magnetic fields propels this cosmic-ray electron deeper into space, soon to be lost forever from the Galaxy.

You bathe in the halo of diffuse matter that surrounds the Milky Way Galaxy — electrons and protons and a few atoms held in the grip of gravity that prevents their escape into the void beyond.

Shift your gaze back to the huge Galaxy in front of you. Enormous pillars of diffuse gas arch out of the Milky Way's disk and into the halo you are speeding through. Though the gas itself moves rapidly, the pillars persist because the galactic magnetic fields that confine them change slowly.

But change they do. Streams of gas driven from dying stars — supernovae that expired in blasts of destruction millions of years ago — push and pull the magnetic fields. The fields between the stars respond to these blast waves, interacting with warm and cold hydrogen gas and with dust to build enormously long filaments. These filaments twist and stretch along the spiral arms, sometimes colliding with each other and becoming unstable as they try to rid themselves of the winds of charged particles that blow, hurricanelike, through space.

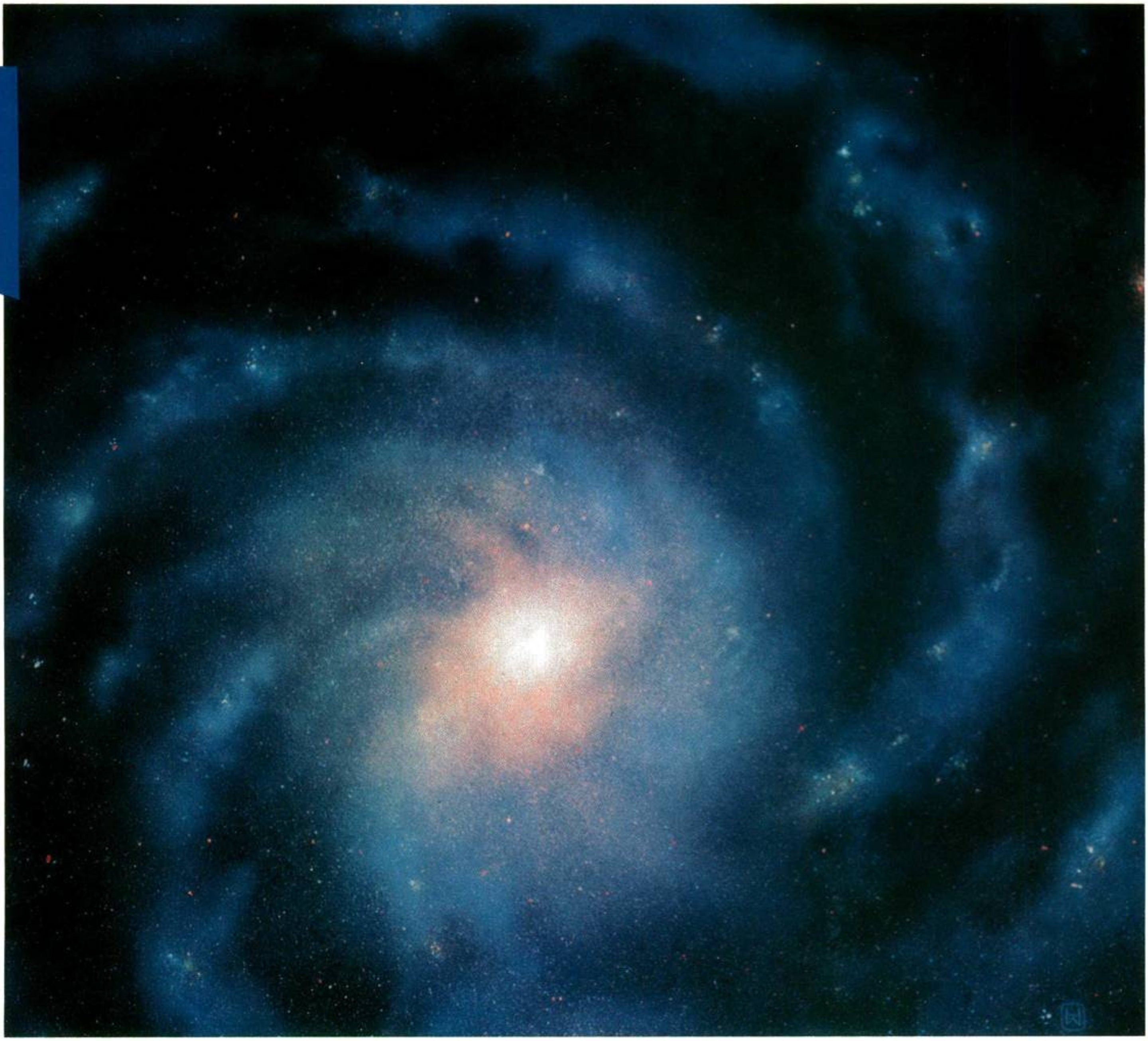
All these events occur so slowly that you can barely see the changes, even from your ship. But the signs are there. Constant turmoil is the hallmark of interstellar space.

### Toward the Galactic Disk

It is time to move on. You still have five weeks of hard traveling before reaching the galactic disk. You target a spot in the spiral arms and lie back, enjoying the sight of the Galaxy that now fills your field of view.

About 15,000 light-years from the Galaxy's disk, you notice a particularly bright globular cluster off to your left. This is the biggest and brightest one you've seen on your voyage and it's definitely worth a short side trip.

As you pull closer, you see the outer part of the sphere resolve into countless yellow-orange stars. Even



William K. Hartmann

the central region begins to break up into individual stars. Though thirty stars crowd into each cubic light-year in the core, you're now so close that you can see completely through the cluster.

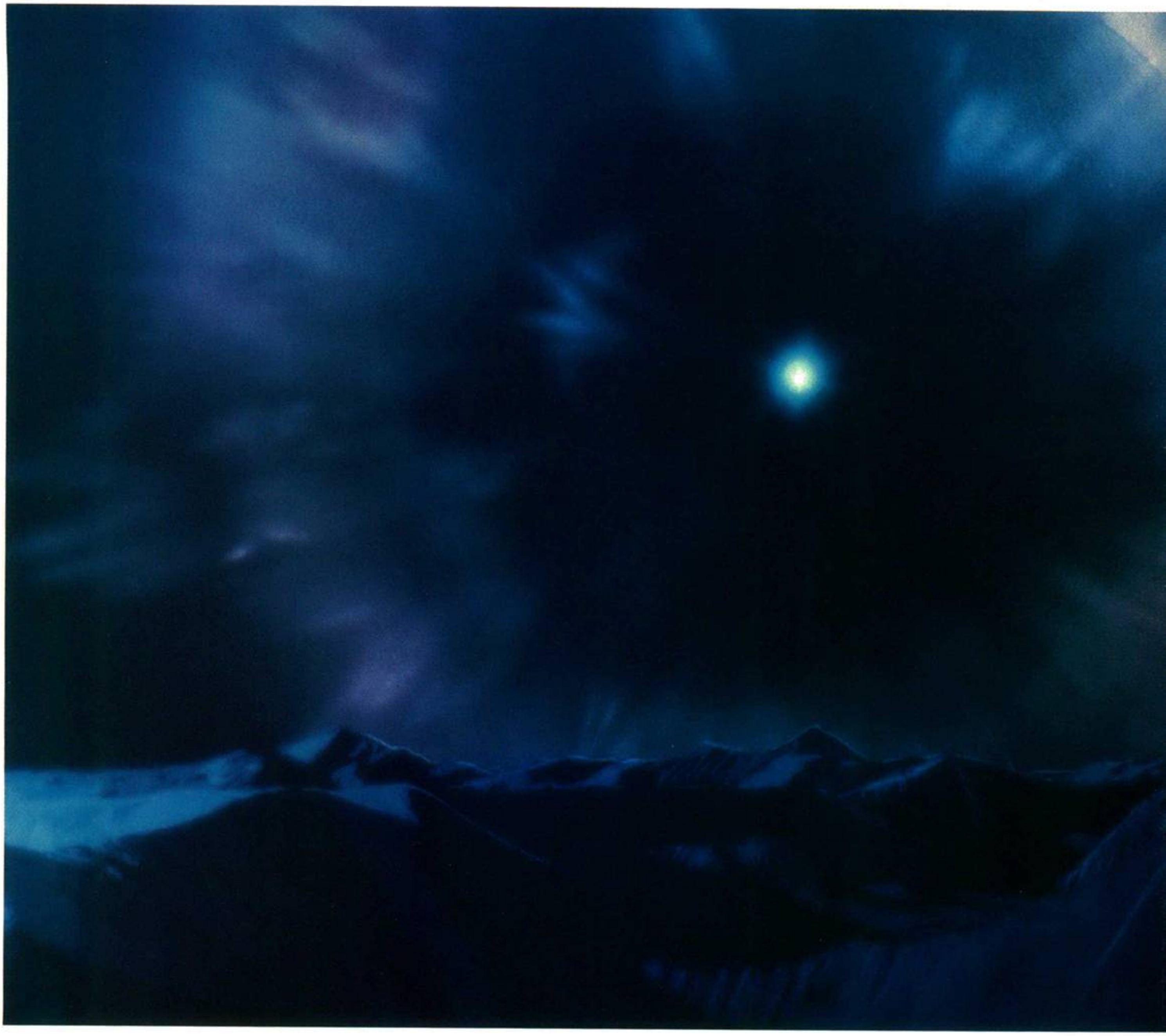
The overall size of the cluster is also amazing. Several hundred thousand stars, maybe even a million, fill a sphere some 135 light-years across. Even though your ship is hurtling by at a million times the speed of light, which itself is an incredible 300,000 kilometers per second, it takes over an hour to traverse the cluster. Earth-based citizens know this gem as 47 Tucanae. The name seems too prosaic for such a grand object.

As you pull away from 47 Tucanae, the galactic disk stands invitingly before you. You scan the disk and decide to aim for a particularly bright region of gas and dust located about halfway between the Galaxy's center and edge.

You swoop toward the fiery glow, which is located just a few hundred light-years below the plane of the Milky Way. A host of hot young stars lies embedded in the gas and dust, each emitting prodigious amounts of ultraviolet radiation. The hydrogen gas surrounding the stars absorbs the ultraviolet and reemits it as red light, giving the nebula a characteristic ruddy glow.

Tune now to infrared radiation and watch the whole region come alive. Everywhere you look you see brightly glowing clouds of dust, enshrouding stars that are condensing out of the abundant interstellar gas in the region. Thousands of these young, still-forming stars, or protostars, are poised to burst out of their dusty cocoons once the nuclear furnaces in their cores ignite. Some of these stars will shine for just a few million years while others will live 100 billion years or longer, but in every case the star's energy ultimately comes from the nuclear fires of fusion in its core.

For now the protostars gather their resources in preparation for starbirth. Around them matter swirls in chaotic motion. Colliding particles accrete into large solid objects, planets in a state of coalescence, some of them possible homes for future life.



### Homing In on the Sun

You move off again, this time heading along the galactic disk toward the center of the Galaxy. After a short, 1,200-light-year jaunt, you approach an average-looking yellow star. You glance behind, toward the nebulosity just visited. It lies below a string of three moderately bright stars. Of course! You've heard about that. It's Orion's Belt. You were just exploring the Orion Nebula, so the yellow star ahead must be the Sun. It appears in a spur of gas and dust bridging the space between two spiral arms that wind inexorably into the center of the Galaxy, lost in the distant gas and dust.

You glance back toward the outer part of the galactic disk and notice immediately a brilliant band of starlight lying some 6,000 light-years away. Incandescent with the light of millions of young stars, this is the Perseus spiral arm, the next one outward from the Sun's. Stars gather in clusters far different from the globular clusters you saw earlier: the globular clusters held hundreds of thousands of cool, ancient stars in a densely packed sphere; these open clusters have a few hundred hot, young stars grouped fairly loosely, the brightest two clusters being h and Chi Persei.

Tune in to the radio waves emitted by the hydrogen gas between the stars and an overwhelming new spectacle unveils itself. As far as you can see, the Milky Way Galaxy appears to be a tangle of glowing hydrogen tendrils held in sway by magnetic fields. The glow varies in frequency — it is slightly higher when the gas moves toward you and slightly lower when the gas moves away. This subtle shift in frequency happens whenever a radiating object moves radially.

As you look from one side of the galactic disk to the other the hydrogen emission reveals a subtle, systemic change in frequency, the signature of the Galaxy's rotation. The Galaxy rotates ever so slowly — the Sun and its neighbors take 240 million years to orbit the center once. Yet every star and atom of gas and dust at this distance hurtles through space at 220 kilometers per second.

Looking again toward the center of the Galaxy, you

**A STAR PUFFS OFF** its outer layers, seeding the Galaxy with heavy elements that one day may be recycled in a new generation of stars.

Ron Miller

see that the gas in the spiral arms close to the nucleus is swirling wildly. And there's another disk of matter that is inclined to the much larger disk that makes up the bulk of the Galaxy. The small disk's radio emission reveals that it, too, is rotating, with its outer regions traveling at approximately 100 km per second.

Everywhere you look you can see the telltale shift in frequency that signifies motion. When you glance at the young star clusters in Perseus, you see an enormous shell of hydrogen gas surrounding the stars. But when you focus on the motion, you see that the gas in the shell is streaming away from the clusters and expanding into the space between spiral arms. This supershell contains the energy of a thousand dying stars, a symphony of stellar destruction that sends gas blasting into the 6,000-light-year void between spiral arms in less than ten million years — blasting it so far, in fact, that some gas sweeps toward the Sun.

Once this supershell is identified, others become easier to spot. They are everywhere, fossil fragments of ancient explosions that keep matter between stars thoroughly stirred. Some fragments collide violently, causing molecules to form in the regions of space caught in the vise. The gas piles up, forming globules of gas and dust that, if dense enough, will collapse eventually to form new stars.

Shells of gas that once exploded outward at 10,000 km per second when stars died now are slowed to barely perceptible velocities. Their trajectories carry but the faintest memories of where they originated.

You return your gaze to the region of the Orion Nebula and note another gaseous shell, this one moving out from Orion. The shell expands away from the site of an ancient explosion lost in the mists of time, helped along by the combined effect of the winds from a hundred young, hot stars. People orbiting the Sun call this immense structure the Eridanus shell.

And in fact, the Sun itself lies in a relatively empty volume of interstellar space about one hundred light-years in diameter. Little gas exists inside this bubble, perhaps because a long-forgotten supernova swept this matter away.

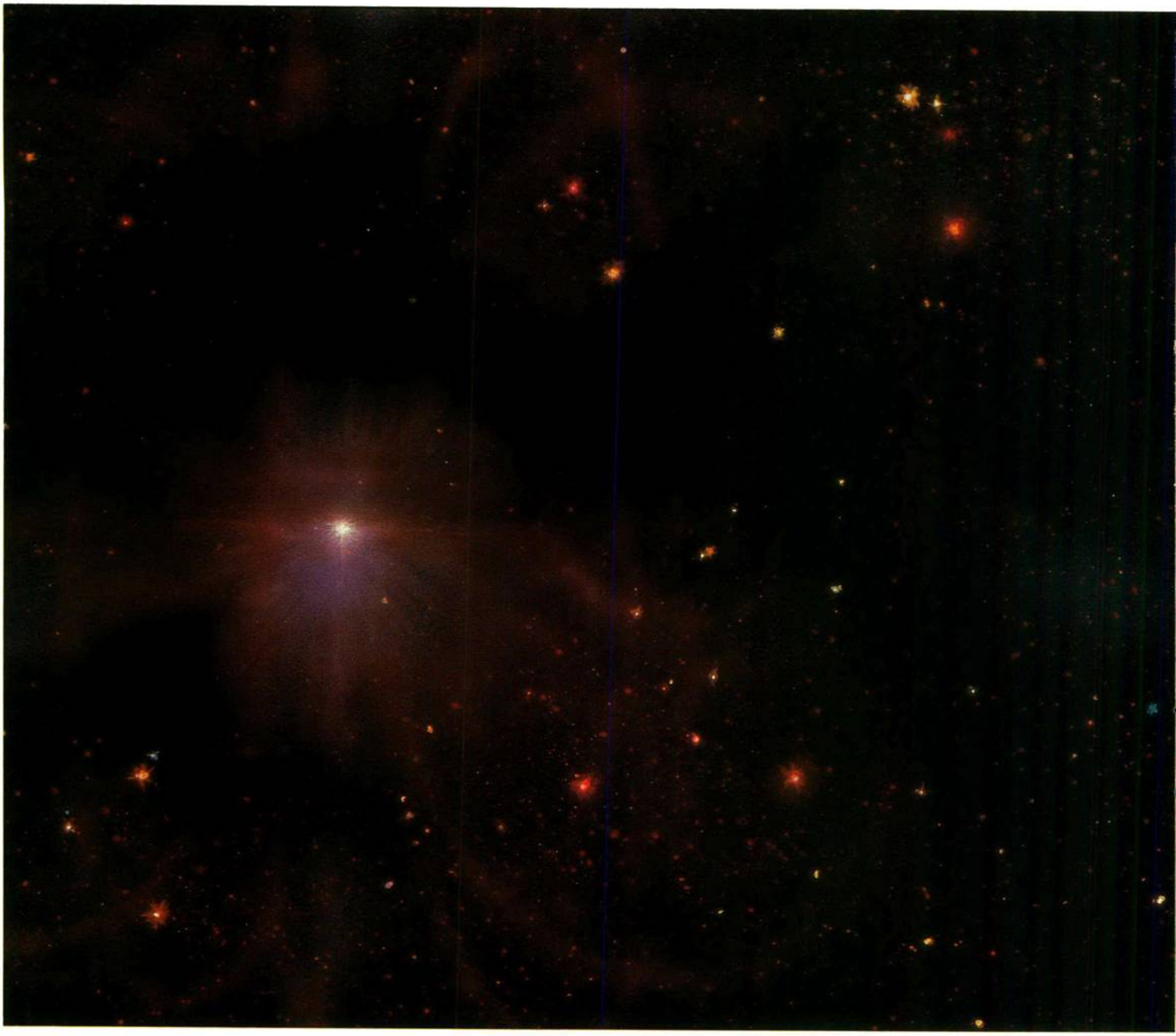
### A Star Dies

Time to move on once again, to head for that brilliant glare of starlight that marks the center of the Galaxy 27,000 light-years in the distance. A little over 300 light-years into the journey, you pass near a mammoth, orange-colored star. Though you've seen many giant stars on your trip, none have been quite as big as this one. You decide to glide closer to this ruddy supergiant star known to Earthlings as Antares. You speed up time and gaze into the star's interior. Layer upon layer of heavy elements form concentric shells, each blazing with energy from nuclear fusion, each converting some form of matter to a more complex, heavier element. In the core's outer layers hydrogen turns to helium. Below it a layer of helium burns to form carbon and then oxygen beneath that. Deeper still, heavier elements are cooked up in this cosmic blast furnace.

At the core you focus on a large mass of iron. No nuclear energy radiates from the iron core because fusing iron requires energy. You realize Antares has reached the end of its life, so you wait and watch.

Suddenly the core collapses because the inert iron core can no longer support the layers above. It's going supernova! Electrons are driven into protons, forming a ball of rigid neutrons. As this event plays itself out, you feel a tingle of neutrinos coursing through space, messengers of what you are about to see.

The outer layers of Antares' core collapse onto the solid ball of neutrons. The gas then bounces and tears outward, heating what used to be the outer layers of the star to a million degrees. The star explodes in a fiery brilliance that shatters the heavens, and energies of all sorts — gamma rays, X rays, ultraviolet, visible light, infrared, even radio waves — pour forth from the cataclysmic supernova explosion. As the star explodes into the



emptiness of space, it drags along the elements patiently cooked during the last few million years and adds to that mixture even heavier elements transmuted in the energy of the blast.

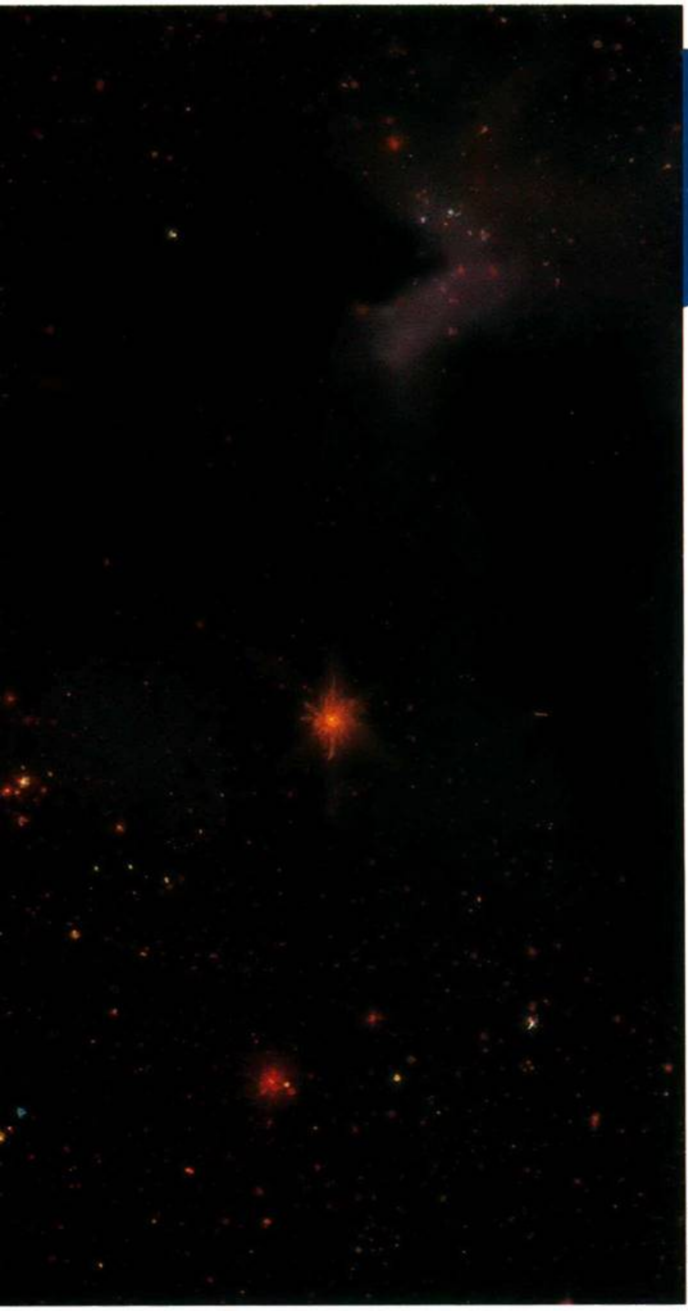
You back away and watch those unfortunate planets orbiting Antares evaporate. In a split second, every trace of them turns into insubstantial gases propelled back into the space from which they came.

The supernova glare subsides and swirling filaments bubble out into space. Left behind is the rapidly spinning core of neutrons, which transmits an endless train of energy pulses — beep, beep, beep — as a hot spot near its magnetic pole repeatedly sweeps past you. Antares has been transformed into a pulsar whose signal one day will be heard throughout the Galaxy. You tear yourself away, aware that you have been under the spell of the spectacle of star death and ready to pause near any other star that even hints at approaching its spectacular end.

You continue, zooming through the Sagittarius spiral arm, the next one toward the center of the Galaxy. You cut through several more spiral arms, each several thousand light-years wide. You travel through relatively dark regions between the arms, where an abundance of old stars hang in mute obedience to the force of the Galaxy's gravity.

You travel toward the Galaxy's center, pursuing another massive star. You stop. This is a more massive star — it should make for a doozy of a blast! You sense a rush of gravity waves. They begin to toss you this way and that, a sure sign that something catastrophic is happening deep within the star.

The explosion rocks you mercilessly. But as the explosion's debris begins to clear, you notice something odd — the spot where the star used to be appears totally empty. Of course! The star was so massive that when it collapsed, the neutron core was not strong enough to halt the matter that was *pouring in*. The star disappeared into its own gravitational field. It became a black hole; from now on nothing will ever escape from it. No light,



William K. Hartmann

THE HEART OF THE MILKY WAY features gaseous filaments confined by powerful magnetic fields and an intensely bright source that may mark the location of a supermassive black hole.

no radio waves, no X rays. Wrapped in their own gravitational web, the remnants of that star's death have separated from the universe in which you live.

But the black hole still affects the universe through the force of its gravity. From a safe distance a few million kilometers away, the gravity seems no different from that of a normal star of the same mass. But within a few kilometers of the black hole, the invisible object's gravity would rip you and your ship to shreds through the strength of its tidal forces.

### Into the Core

Now, the final leg of your journey, the one taking you into the Galaxy's nucleus. You travel through the spiral arms that wind into the galactic bulge and past a ring of gas and dust that appears to be moving outward as if trying to escape the tug of gravity arising from the heart of the Galaxy. You're ten thousand light-years from the nucleus, and here the Galaxy both looks and feels different.

Endless swarms of cosmic rays driven by ancient supernovae compete with the bright glow of X rays from the hot gas between the stars. The chaos is interlaced with dense clouds of cold gas and dust, all laden with complex molecules. In fact, several giant molecular clouds reside in the Galaxy's inner sanctum, with each producing large numbers of stars. The largest giant molecular clouds contain nearly a million times the mass of the Sun, and the average density of the gas in the nucleus is about one hundred times greater than in the galactic disk at the Sun's distance.

You travel onward until you approach the nucleus, which is hidden behind a thick wall of encircling gas and dust. You enter a region where gas and dust are again pushed outward, forming a shield of matter. Inside it, stars dominate. At a distance of one hundred light-years from the center, magnetic fields twist together. The field lines seem to emerge from the darkness of intergalactic space, to twist and turn with the Galaxy's rotation, and then to wander out along the spiral arms of the Milky Way.

Countless energetic particles spiral around the magnetic fields to cause a vivid radio glow, while near the galactic nucleus long, thin gaseous filaments radiate their own signature of light, infrared, and radio energy. And there, around the core, countless stars and clouds of dense molecular gas seem to be swirling far too wildly. What is pulling them? There is only one way to find out. Cautiously you move closer.

You've heard that supermassive black holes may lie at the centers of most spiral galaxies. Your curiosity urges you closer to the vividly bright source of radio waves that outshines almost everything else in the Galaxy. Something remarkable must be happening there.

You move even more carefully. The motion of the stars tells you something massive is pulling at them. If it is a black hole, it probably contains a few million times the mass of a typical star, so you'll need to be extra careful.

You move to within a light-year of the center. A large, superheated ring of gas spirals into an invisible object right at the Galaxy's center. You feel a strong flux of gravity waves from the center, a convincing sign of what is there.

Pulling even closer, your detectors start to go crazy, swamped by the intense radiation. Although you want to go on, you know it's way too dangerous. You make a fast exit, speeding out of the Galaxy and back toward the Large Magellanic Cloud.

Arriving home, you take a long look at the Milky Way. The brilliant star clusters, luminous nebulae, and glowing supernova remnants now seem like old friends, though the energetic core remains mysterious. Perhaps you'll return one day and have enough courage to go just a bit farther. ☐

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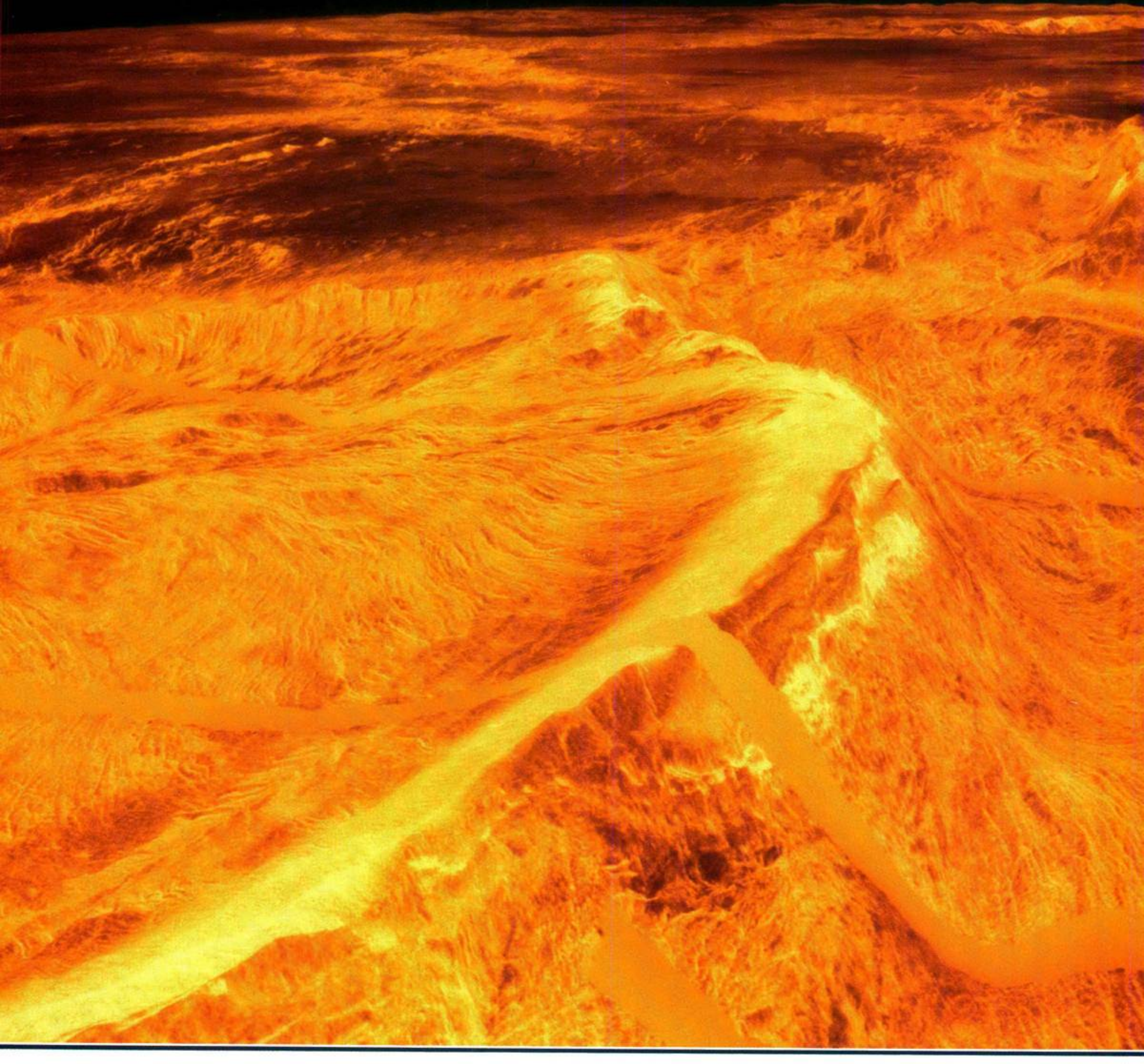
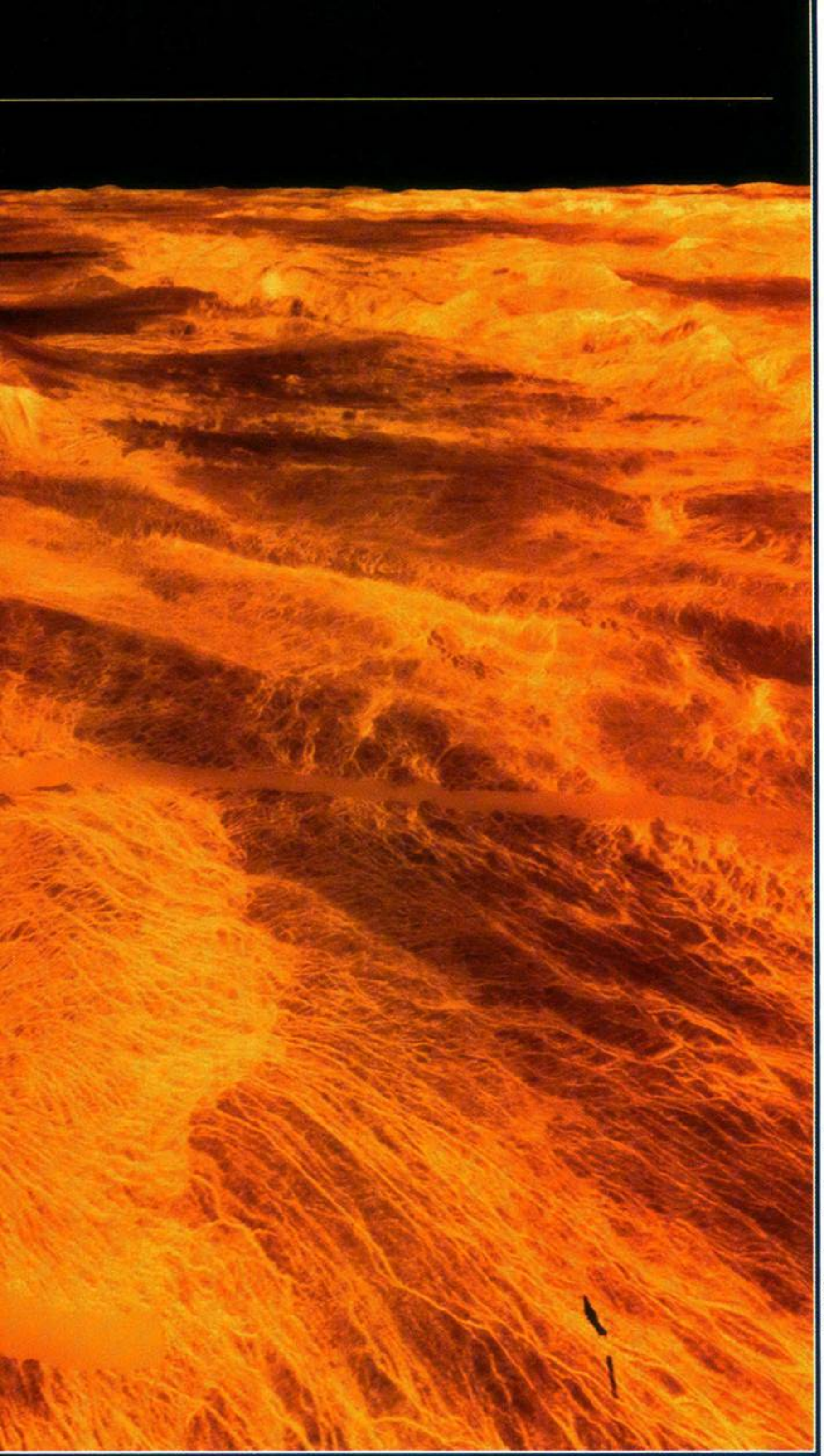
*Gerrit L. Verschuur is a radio astronomer and freelance writer living near Memphis, Tennessee. His last article was "Mysterious Sungrazers" in the April 1992 issue.*



# WHAT MAKES VENUS GO?

"Earth's twin" isn't, by a long shot. It's more a case of arrested development. One reason may be that Venus lost its ocean long ago.

**By Robert Burnham**



All images courtesy JPL/NASA unless otherwise noted

Last September the Magellan spacecraft completed its third radar mapping cycle of Venus. About 99 percent of the planet is now imaged. At the same time planetary scientists met at the California Institute of Technology in search of answers to major questions regarding the planet: What is the "geological style" of Venus? How does it work? Why doesn't Venus have Earth-like plate tectonics? What has been the planet's history?

Heat appears to be the key to understanding Venus. All planets retain heat left from their formation and from the decay of radioactive elements. On Earth, heat flow drives a process called plate tectonics, which creates new crust. Scientists expected Venus to follow suit because it is virtually Earth's twin in size.

Earth's crust is divided into many plates. Each is a rigid piece of basaltic rock bounded by long narrow zones (such as the Mid-Atlantic Ridge) where molten basalt oozing up from the mantle pushes the plate sideways. After millions of years the displaced crust reaches an ocean trench such as the western coast of the Americas or Japan where it buckles downward and slips beneath a continental edge. Returning to the mantle, the crust eventually melts and is re-erupted.

Venus, however, has no such tidy cycle. "To understand Venus, start by imagining Earth with plate tectonics stalled out," says Sean Solomon of the Carnegie Institution of Washington. Thanks to Magellan, Venus is now better mapped than Earth (where fully detailed charts of the ocean basins remain military secrets). It's clear, though, that Venus has no plates like those of Earth.

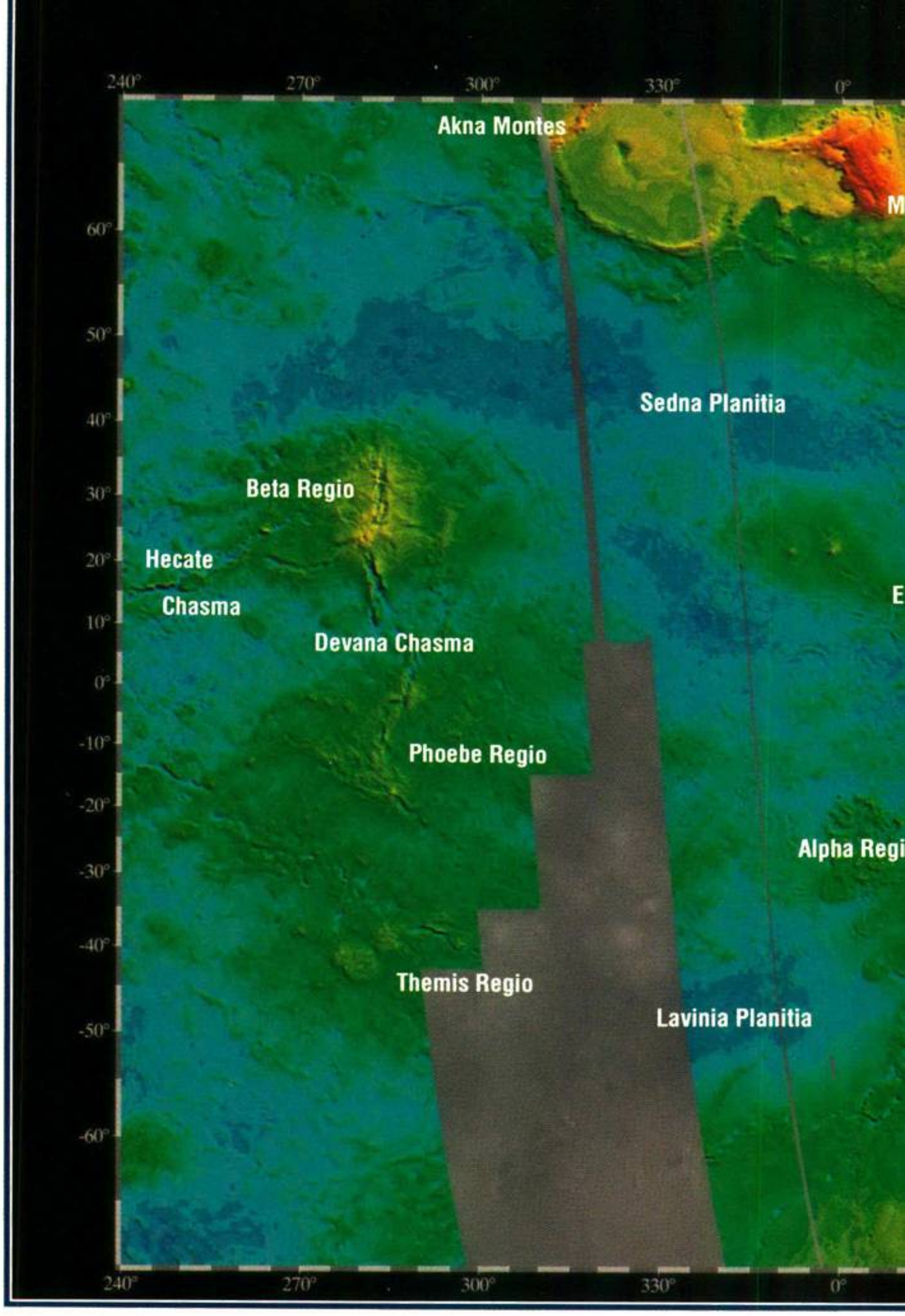
In fact, some scientists think Venus became a one-plate planet when its surface got *too* hot. On Earth, the cold surface temperature helps keep oceanic crust rigid. But if Venus started with an ocean, it is long gone and the surface is now halfway to the melting temperature of rock. Its crust therefore is ductile. Like a giant "soft batch" cookie that's ever pliable, the Venus crust isn't stiff enough to slide around in large, intact pieces. Instead, when subjected to forces from within, the Venusian crust wrinkles and puckers largely in place.

"It's likely that Venus is actively building mountains at present," says Solomon. So far scientists have seen no clear evidence for surface changes during the mission, he says, but "high mountain regions like Maxwell Montes will collapse under self-gravity in about 10 million years." Either

**HIGH AND PRECIPITOUS**, the cliff at the edge of Dali Chasma (foreground) shines bright where the ground has weathered. The dark area just below the lip is a relatively fresh landslide. (Vertical exaggeration is 10x; missing map tracks have been filled by interpolation.)

**A**

Peter Ford, MIT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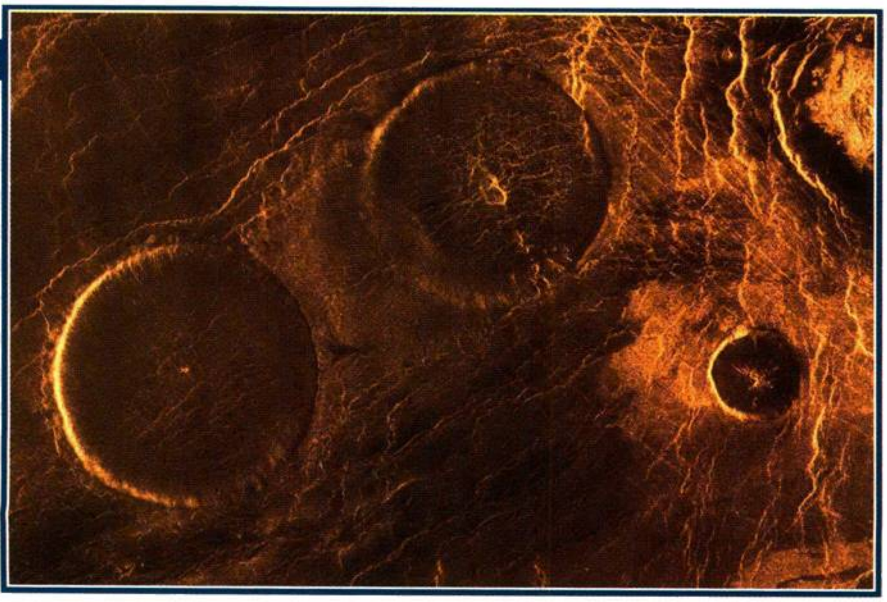
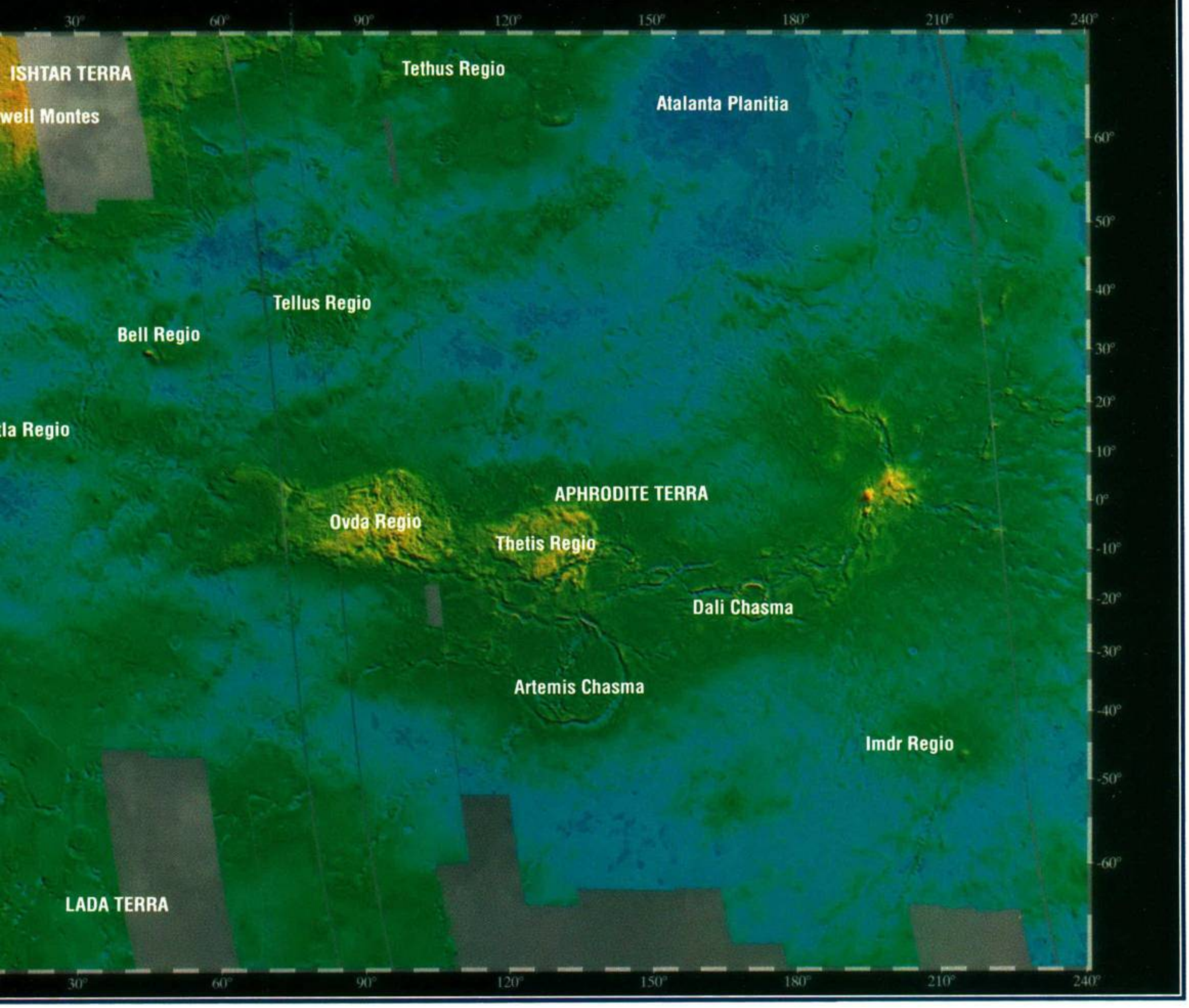


**C**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Artemis Chasma
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**THE NEW FACE OF A WORLD** appears in Magellan's radar map (above), which has many times the detail of the similar map created by Pioneer Venus a decade ago.

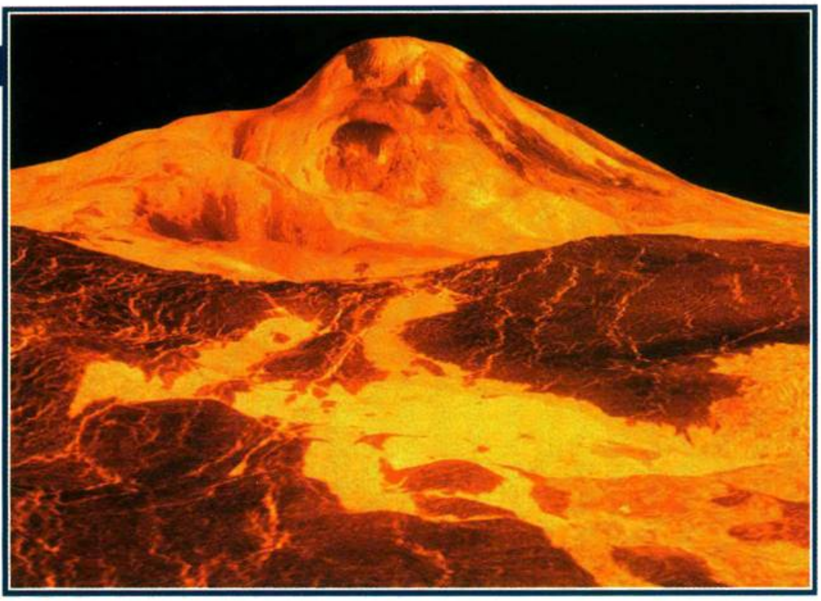
**A: A DIRECT HIT** on the Akna mountain belt. Lava flooded this 22-kilometer crater, but the lack of subsequent deformation shows that the forces that folded the mountains have been quiet since the impact.

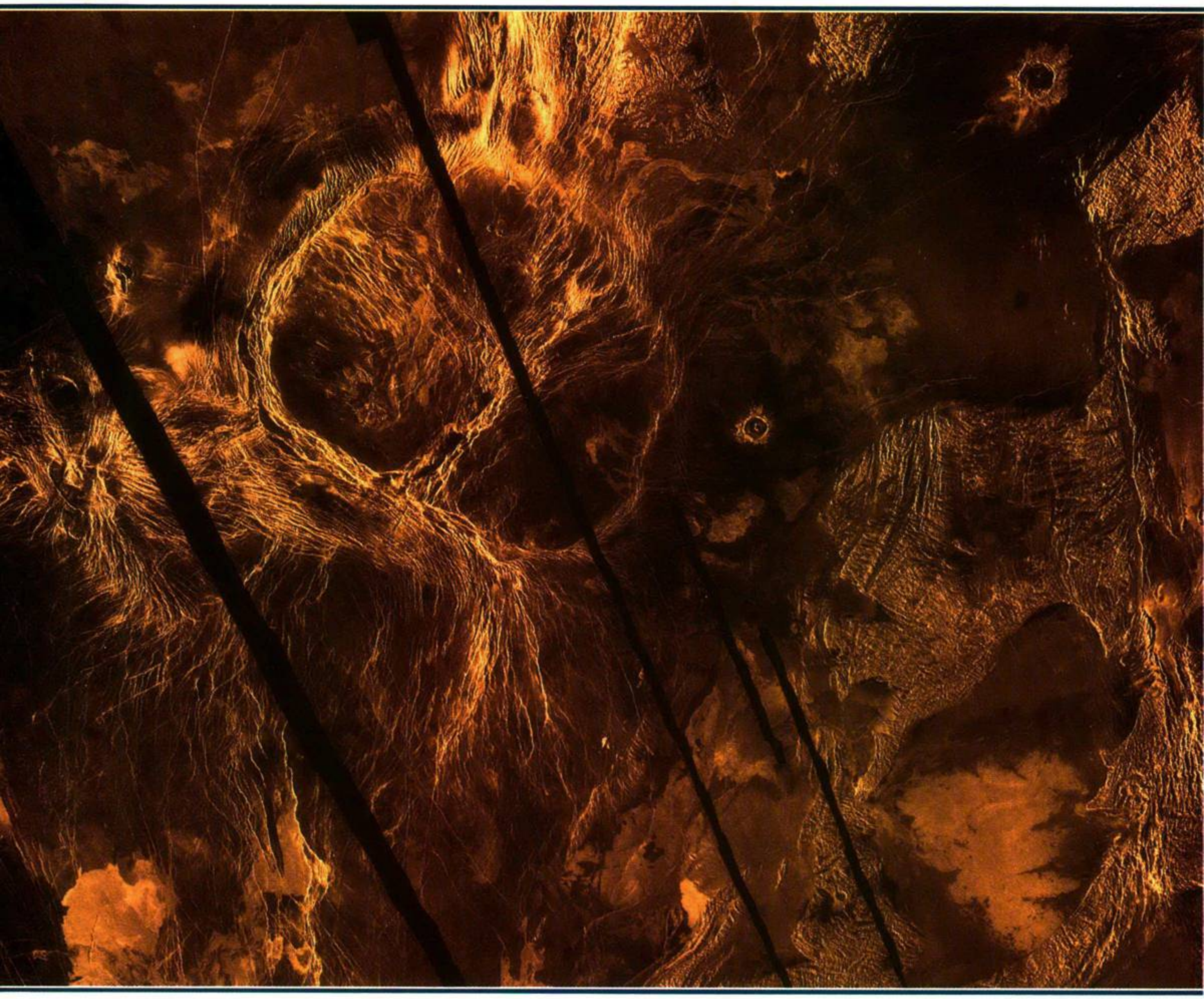
**B: STIFF AND THICK AS BATTER,** the lava that made these 65-km-diameter pancake domes was more viscous than most on Venus.

**C: MULTIPLE ERUPTIONS** show in this volcanic structure with a beautiful "fan" of lava that's over 100 meters thick at one edge.

**D: RISING MAJESTICALLY** and draped in fresh (dark) lava flows, Maat Mons stands 8 km high. (Vertical exaggeration 10x.)

D





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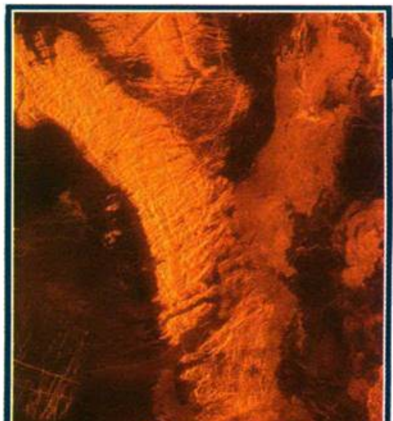
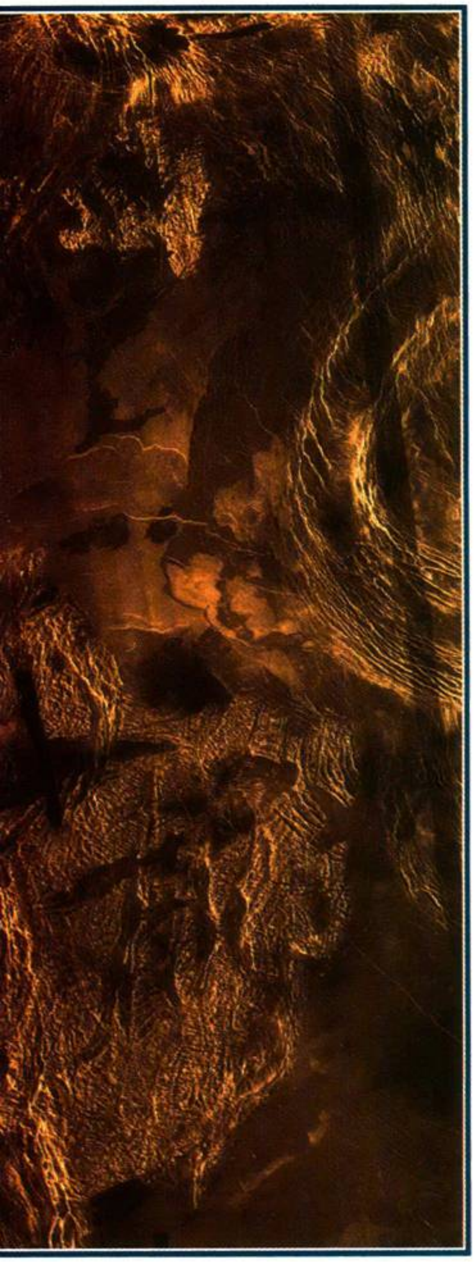


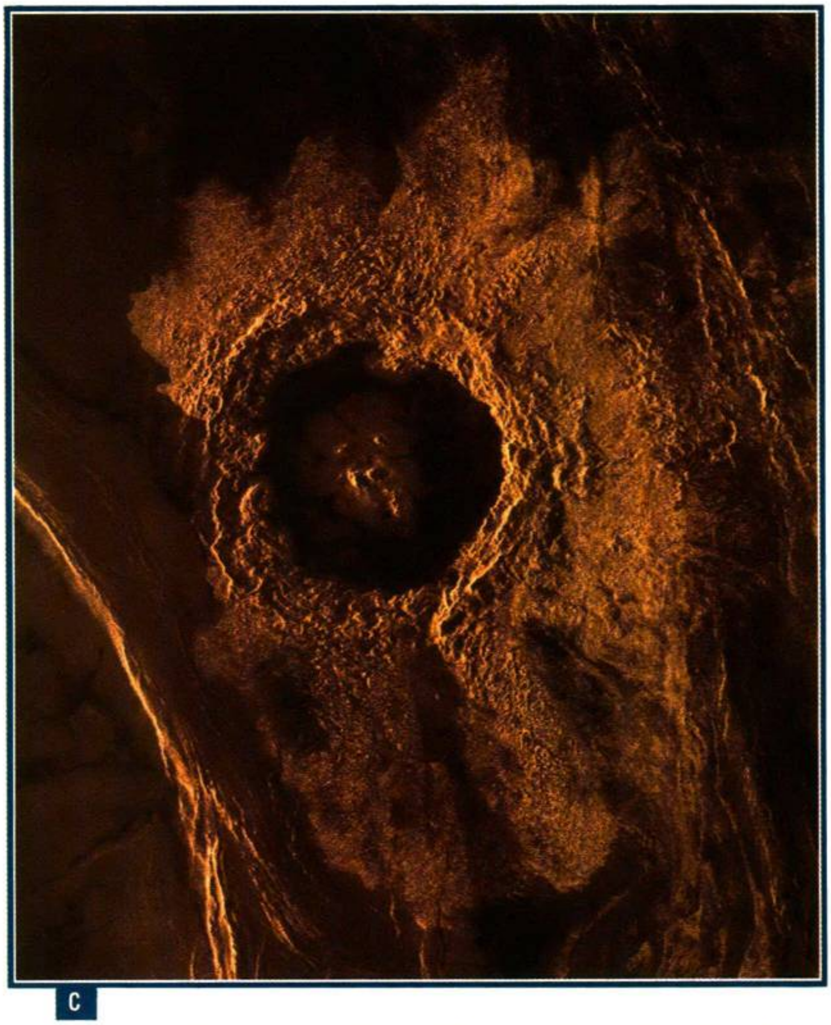


**A GEOLOGICAL TANGLE**, Lada Terra (above) contains many kinds of features, from small impact craters to the giant oval features called coronas, which are found only on Venus. Eithinoha corona (upper left) is 500 km across.

**A: TWO ODDLY SHAPED DOMES** lie in Beta Regio; the larger is 45 km across and has steep interior slopes.

**B: CRATERS FILLED WITH LAVA** are rare on Venus because the surface is largely inactive; Heloise crater (bottom center) is 40 km across. Old, greatly deformed terrain shows bright in the upper part of the image.

**C: A BRIGHT APRON OF DEBRIS** surrounds Dickinson crater, 69 km in diameter, which appears to have been flooded in two or more stages.



C

Magellan caught Venus at a lucky moment or mountain-building is continuing.

The small number of craters tells Venus scientists that nearly all the present surface is no older than about 500 million years old. That's about twice the average age of Earth's surface, but eight times younger than the Moon's. Researchers disagree sharply, however, over how it came to be that old.

Gerald Schaber of the U. S. Geological Survey is one of many who think resurfacing occurred in something of a spasm that trailed off abruptly about 500 million years ago. Roger Phillips of Washington University in St. Louis represents a smaller number of scientists who believe resurfacing continues intermittently today. Both sides agree it will take a lot of careful mapping to settle the matter.

Donald Turcotte of Cornell University has proposed that resurfacing could run in cycles. Periods like today, with no plate tectonics, would alternate with active periods. As the plate tectonics conveyer belt moved hot mantle material to the surface, it would rob internal heat that makes the process go. With a cool interior, plate tectonics would shut down. Then heat from radioactive decay would start to build again, until it was high enough to trigger another onset. Turcotte thinks this off-and-on cycle would continue until the interior cooled too far to restart it.

Magellan is now in its fourth orbital cycle. Scientists are carefully tracking it to map Venus' gravity field for clues to the planet's interior structure. However, the craft confronts an uncertain future, both at Venus and on Earth. Its transmitters are overheating and can no longer make radar images. Back here, Magellan faces a different kind of heat: the federal budget. With Mars Observer and Galileo en route, the Cassini Saturn orbiter in development, and many exciting new projects planned, NASA is skeptical about spending already tight funds to extend Magellan's mission past May 15, the end of cycle 4.

If mission planners do get an extension, they will dip Magellan into the upper atmosphere. This would produce a lowered circular orbit and greatly enhanced gravity measurements. However, the price tag for extending the mission is $30 million, and the project's scientists are glumly aware that this money may be more needed elsewhere. ☐

# BUBBLES in the Sky

Interaction between stars and the interstellar medium paints our Galaxy with bubbles and bow shocks. What creates these works of art?

by Dave Van Buren

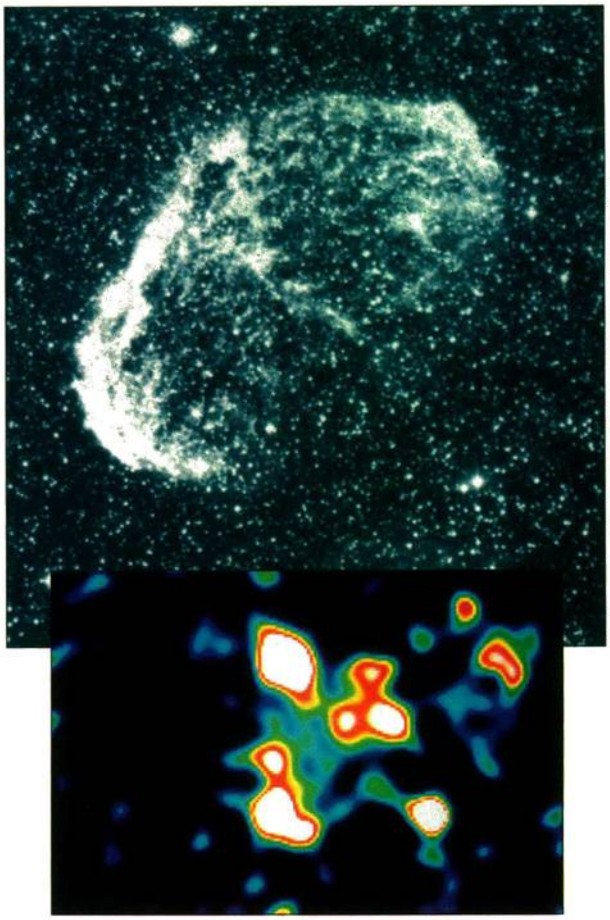
Spiral galaxies are pretty smooth operators, at least viewed from afar. They appear to have a nice, orderly disk of stars, gas, and dust slowly pinwheeling around a bright center. At first glance the interstellar medium, the matter that fills the space between the stars, is pretty mundane — a thin, smooth soup of particles without apparent function in the grand scheme of the galaxies.

But a closer look at the interstellar medium reveals a more tangled reality. In the Milky Way Galaxy, for example, astronomers see extraordinary activity in the interstellar medium. Fierce stellar winds, hot temperatures, and stars traveling at high velocities create bow shocks and bubbles, or shells. Apart from being works of art on a cosmic scale, these unusual structures hold a great deal of information about how stars behave. And because stellar winds acting over long periods of time create many of these bubbles, the bubbles shed light on how stars lose mass over the course of millennia.

Our Galaxy is peppered with bubbles, which exist virtually anywhere intensely hot stars exist. Extremely hot stars with powerful stellar winds interact the most with the interstellar medium because of the winds and the effects of intense radiation. So scientists focus their research on two types of hot, energetic stars: O stars and Wolf-Rayet stars. O stars are normal stars with masses more than 15 times that of the Sun. In fusing hydrogen into helium at a terrific rate, these stars burn very hot, at temperatures above 30,000 K. They create winds that carry away up to 100 trillion tons of material per second at speeds of up to 3,500 kilometers per second. The force of these winds is so strong that it pushes the surrounding medium — gas and dust — out to distances of light-years away from the star. Some stars, such as Wolf-Rayet stars, have even more powerful stellar winds. These winds push tenuous material into shells, contributing even more matter into bubbles than the O stars do.

Just how does the Galaxy lend itself to bubble making? The scenario for creating a bubble is simple. Suppose you have a newly formed O star sitting in a region of the Galaxy that contains dense interstellar gas and dust. At first, the star's wind rushes outward and sweeps the surrounding medium into a thin shell. Very quickly, after about a thousand years, enough

**AN INTENSELY HOT WOLF-RAYET STAR** created the bubble known as NGC 6888 in Cygnus (below). An X-ray image of NGC 6888 (bottom) made with the Einstein Observatory shows in false colors the highest energy regions of gas.



Photos courtesy Mordecai-Mark MacLow/NASA Ames Research Center

**A GIANT COSMIC BUBBLE**, the Rosette Nebula in Monoceros (opposite page) was blown by stellar winds and radiation from hot O stars in a central open cluster.

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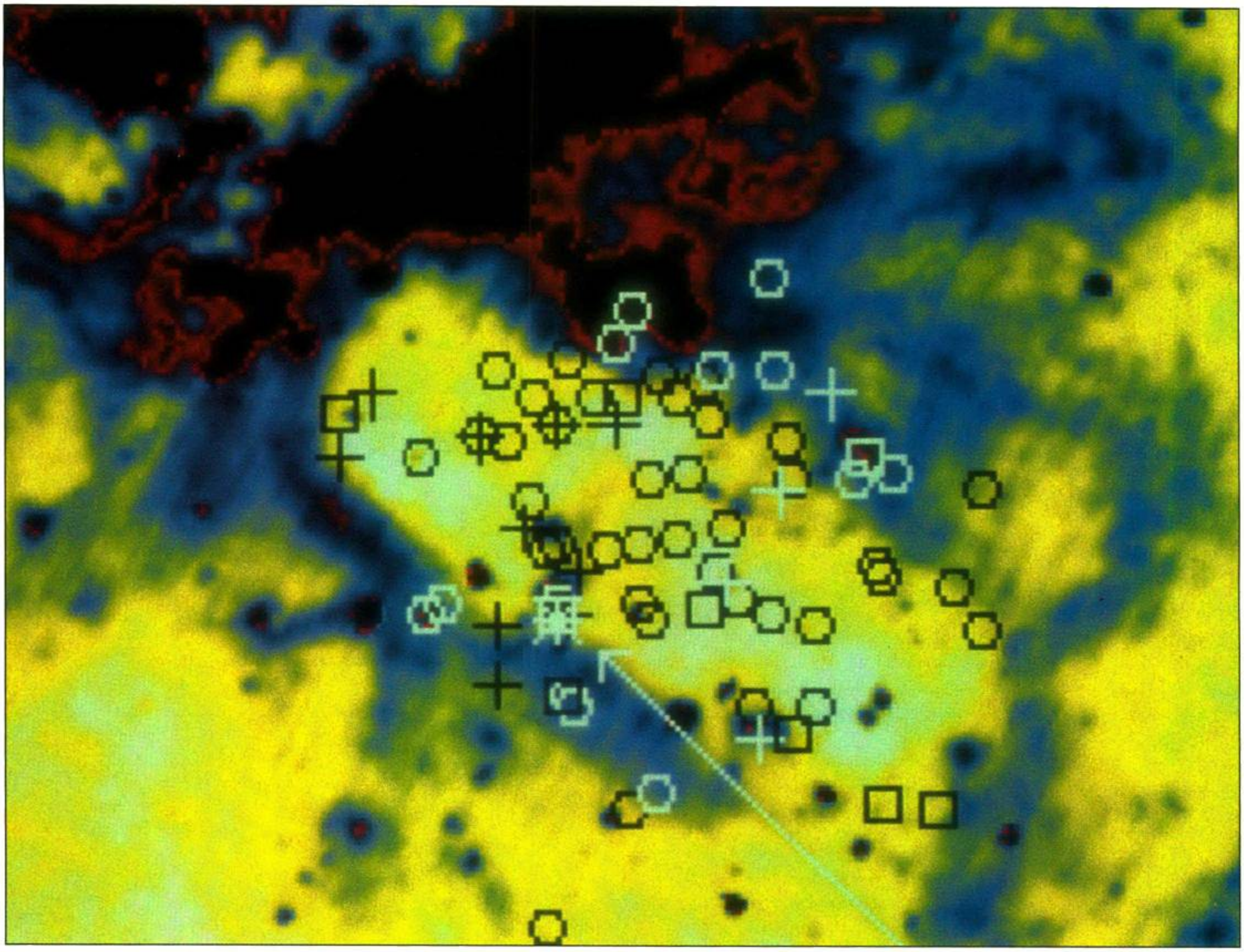


J. Michael Shull/Joint Institute for Laboratory Astrophysics

**THE CYGNUS SUPERBUBBLE,** a shell spanning 400 light-years, is visible as the yellow oval in the center of this false-color infrared image. Crosses and circles show positions of O and B stars; squares show Wolf-Rayet stars. The arrow marks the open cluster Berkeley 87.

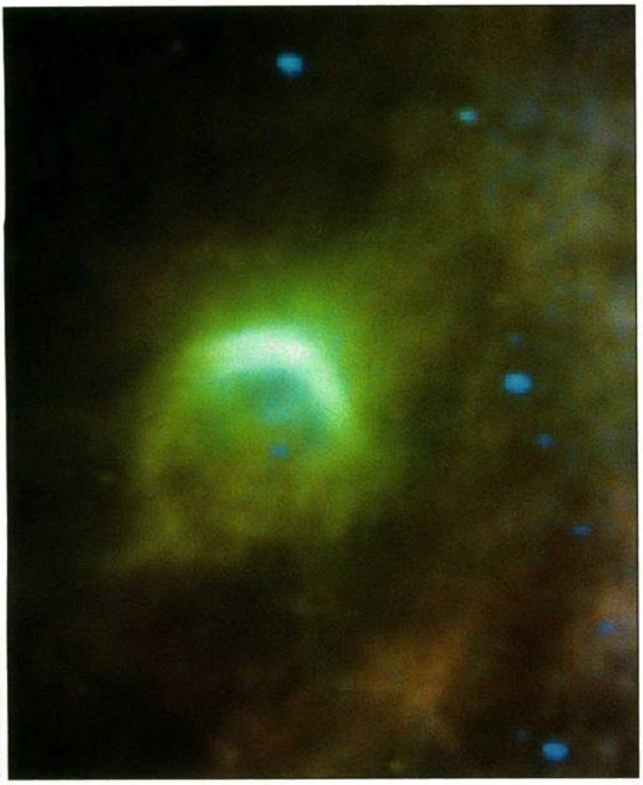
Jack Newton

**A HOT O STAR** formed the shell known as the Bubble Nebula (NGC 7635) in Cassiopeia. It is bright enough and close enough to view with backyard telescopes.

interstellar gas gets swept up that it begins to drag on the outer part of the expanding shell. At this point high-velocity wind from the star overtakes the shell and impacts it, creating a shock wave. As more and more gas is swept up, the shell's expansion slows and the material in the shell merges with the surrounding gas. By this time the bubble could be as big as 300 light-years across.

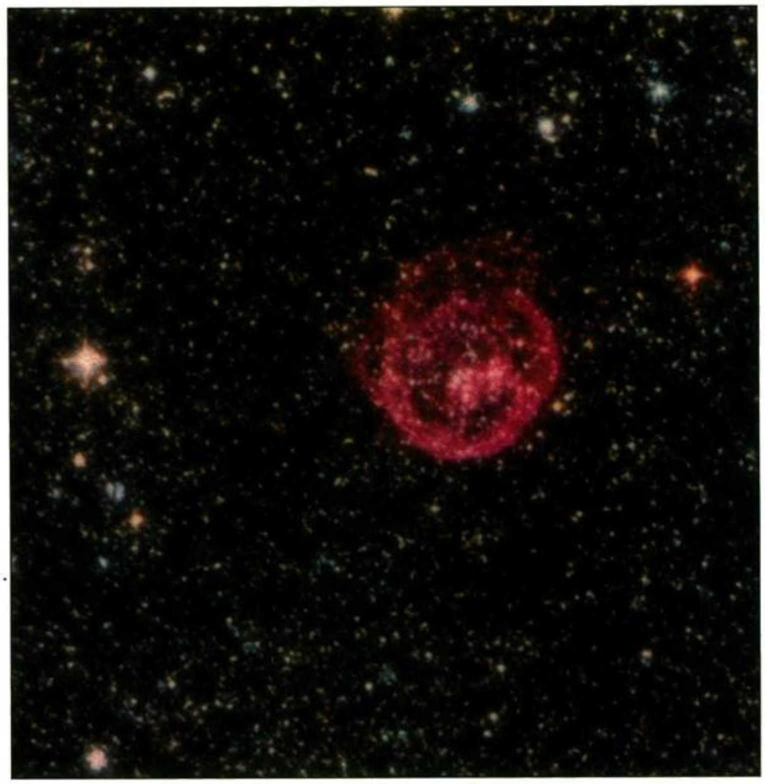
The largest bubbles are young ones surrounding Wolf-Rayet stars, extremely hot stars (50,000 K) that may be O stars stripped out of their outermost atmosphere. The Crescent Nebula (NGC 6888) in Cygnus, which was formed by a Wolf-Rayet star, is one of the brightest bubbles in the sky. Studies of the bubble show that most of the material in NGC 6888 was blown off the central Wolf-Rayet star during an earlier phase of the star's evolution.

Less exotic stars also produce bubbles. Run-of-the-mill O stars create bright, large bubbles, especially when they lie in thick parts of the interstellar medium. The Bubble Nebula (NGC 7635) in Cassiopeia was



Dave Van Buren/IRAS

**PUNCHING THROUGH THE INTERSTELLAR MEDIUM** at extremely high speed, the star Alpha Camelopardalis has created a bow shock nebula.



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**BUBBLES IN OTHER GALAXIES** can be many times the size of those we know about in our Galaxy. This superbubble in the Large Magellanic Cloud surrounds a hot cluster of stars.

created by an O star. Because this star lies in a dense environment, the outside pressure against the bubble is great, keeping the bubble small. Because the bubble's expansion is small, the material pouring out into the bubble from the star reaches a greater density than it would if it expanded farther. Consequently, the bubble is relatively easy to see.

The Bubble Nebula is a case of an O star lying in relative isolation. But most O stars don't exist in isolation. Usually they form in groups. The Rosette Nebula (NGC 2237-9) in Monoceros is the bubble blown by a small cluster of O stars in the cloud from which they were born. The intense radiation from the stars is enough to excite material well past the bubble.

Don't imagine stars such as those in the Rosette cluster as sitting still in space. That's an over-simplification. On the contrary, most hot stars move rapidly through the interstellar medium. Some punch through the surrounding gas and dust at speeds of 100 km per second. These runaway stars, ejected from star clusters, do not create spherical bubbles but shells that resemble comets or the flow around a spacecraft reentering Earth's atmosphere. Such supersonic flows around a star are called bow shocks because they resemble the action of water as it flows past the bow of a ship.

Bow shocks, the ionized regions of matter surrounding high-velocity stars, are even more common than bubbles. The closest O star to Earth, Zeta Ophiuchi, has a prominent one, discovered by Ted Gull of NASA's Goddard Space Flight Center. Shortly after the Infrared Astronomical Satellite (IRAS) gathered data on many O stars, I studied a group of them and found a bow shock around Alpha Camelopardalis, another runaway star. Because the star's wind is rushing outward in all directions, its ability to push material away decreases with distance. The interstellar wind of particles experienced by the star as it moves through space is steady. Because the star's wind decreases in strength with distance, a point exists around each of these stars where the stellar and interstellar winds are equally strong. Astronomers call this the standoff distance, where the bow shock occurs. The bow shock overtakes an unsuspecting parcel of interstellar gas, compresses and heats it, and makes it flow around the star. All the while dust in the gas absorbs starlight, heats up, and radiates energy in the infrared, becoming visible.

The Rosette Nebula, the Bubble Nebula, NGC 6888 — all of these objects are inhabitants of our Galaxy. Bubbles and shells, however, aren't limited to our Galaxy. Astronomers have observed superbubbles measuring hundreds of light-years across in nearby galaxies, including the Large Magellanic Cloud, the Andromeda Galaxy, M33, M101, NGC 55, and NGC 4449.

Studying how hot stars and star clusters interact with the interstellar medium is a new field. But as astronomers compile a record of more and more of these objects, analyzing them at different stages of evolution, they will discover a fuller picture of the story of how stars live and die. □

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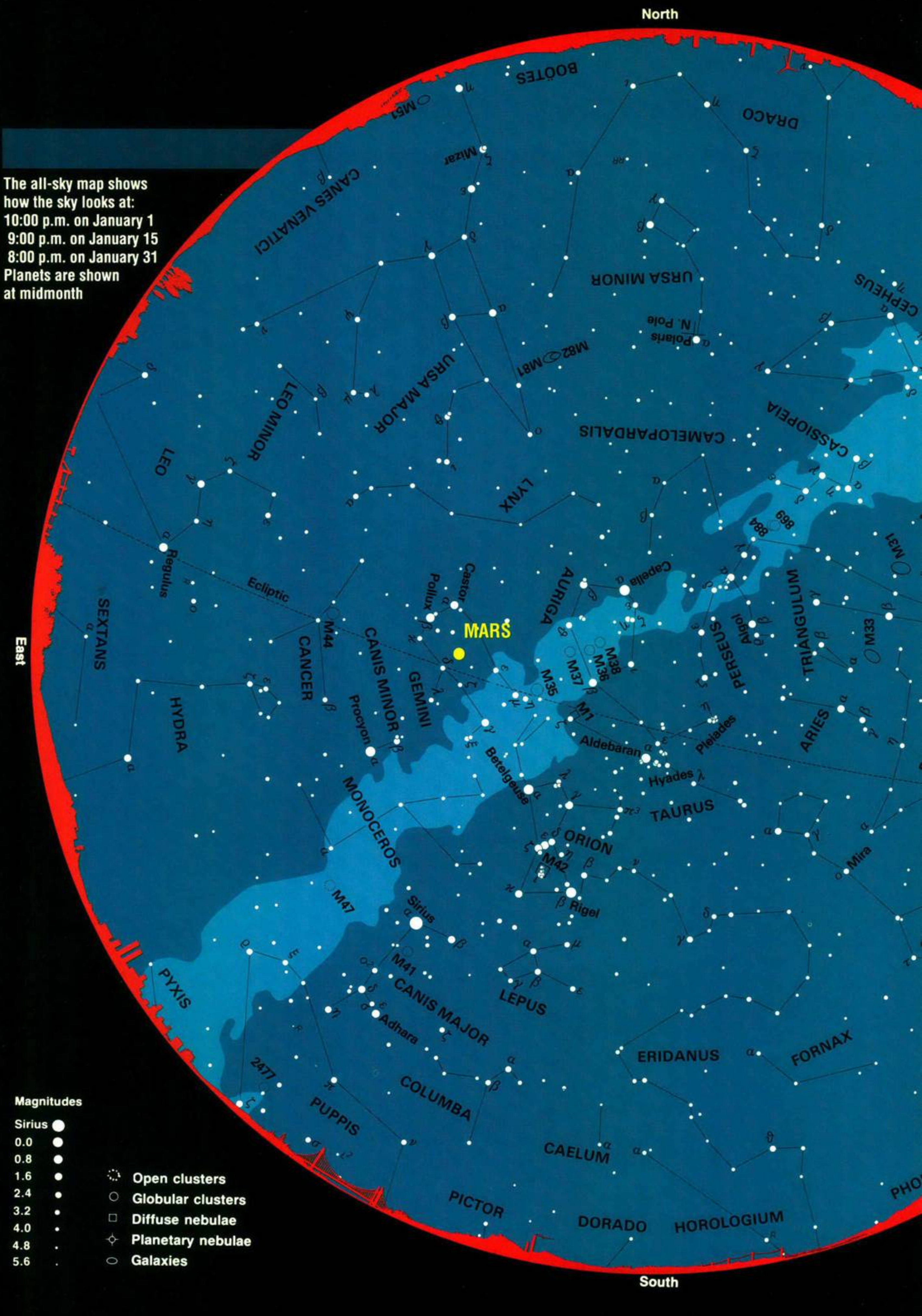
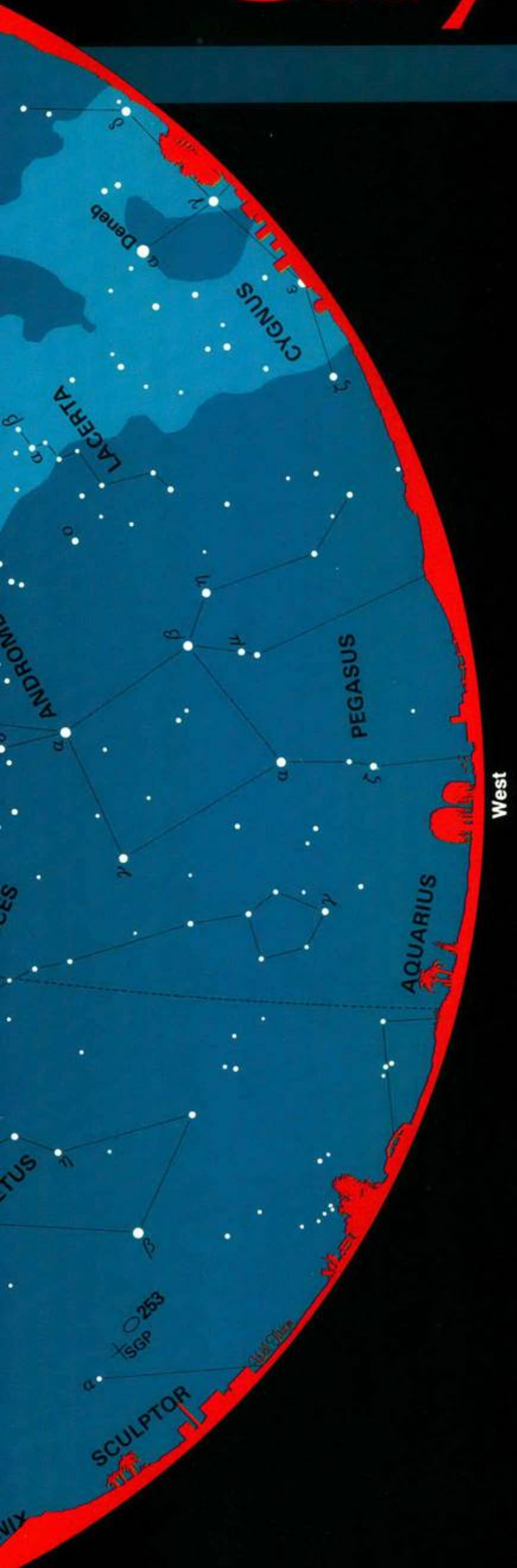
*Dave Van Buren is an astronomer at the Infrared Processing and Analysis Center at the California Institute of Technology.*


North
South
East
BOÖTES
M51
DRACO
Mizar
CANES VENATICI
URSA MINOR
N. Pole
Polaris
CEPHEUS
M82
M81
URSA MAJOR
LEO MINOR
CAMELOPARDALIS
CASSIOPEIA
LEO
LYNX
869
884
M31
Regulus
Ecliptic
Pollux
Castor
AURIGA
Capella
SEXTANS
M44
CANCER
CANIS MINOR
MARS
GEMINI
M35
M37
M36
M38
PERSEUS
Algol
TRIANGULUM
M33
HYDRA
Procyon
M1
Aldebaran
Pleiades
ARIES
Betelgeuse
Hyades
TAURUS
MONOCEROS
ORION
M42
Mira
M47
Sirius
Rigel
M41
CANIS MAJOR
LEPUS
PYXIS
Adhara
ERIDANUS
FORNAX
2477
COLUMBA
PUPPIS
CAELUM
PICTOR
DORADO
HOROLOGIUM
PHO
Magnitudes
Sirius
0.0
0.8
1.6
2.4
3.2
4.0
4.8
5.6
Open clusters
Globular clusters
Diffuse nebulae
Planetary nebulae
Galaxies

The all-sky map shows how the sky looks at:
10:00 p.m. on January 1
9:00 p.m. on January 15
8:00 p.m. on January 31
Planets are shown at midmonth

# Sky Almanac

## January 1993



Map Art by Wil Tirion

### MARS COMES TO OPPOSITION

The Red Planet appears brighter and larger this month than at any time since 1990. A bright orange-red beacon in Gemini, Mars rises in the evening sky and is visible through most of the night. Telescopes will show a magnitude –1.4 disk that measures nearly 15" across and is spotted with dark patches and a bright polar cap.

### QUADRANTID METEORS PEAK

Cometary debris streaks across our sky this month, creating the Quadrantid meteor shower. During the peak early morning hours of January 4, observers will see as many as 80 meteors per hour. Most Quadrantids are short, fast, blue-white or yellow meteors that rarely leave long trails.

### VENUS SHINES IN THE EVENING

On January 19 Venus, the brilliant "evening star," reaches its greatest eastern elongation from the Sun, a separation of 47°. This places the bright planet in its best position in more than a year for evening observations. Look for the planet among the stars of Capricornus and Aquarius.

## Calendar of Events

**3** Mars is closest to Earth
**4** Quadrantid meteor shower peaks
**7** Mars is at opposition, 6 p.m. EST
**8** Full Moon is at 8:37 a.m. EST
The Moon passes 6° south of Mars, 8 a.m. EST
Uranus is in conjunction with the Sun
Neptune is in conjunction with the Sun
**10** The Moon is at perigee (225,100 miles from Earth), 7 a.m. EST
**14** Last Quarter Moon is at 11:01 p.m. EST
**19** Venus is at greatest eastern elongation (47°), 11 a.m. EST
**22** New Moon is at 1:27 p.m. EST
**23** Mercury is in superior conjunction
**25** Uranus passes 1.1° south of Neptune, 3 p.m. EST
**26** The Moon is at apogee (252,293 miles from Earth), 5 a.m. EST
**27** The Moon passes 5° north of Venus, midnight EST
**29** Jupiter is stationary
**30** First Quarter Moon is at 6:20 p.m. EST

# Eye on the Sky

by Deborah Byrd

## MARS AT OPPOSITION

Mars is the gem of the evening sky this month, brilliantly shining high in the eastern sky at mid-evening. On January 7, we pass between Mars and the Sun for the first time since November 1990. This is an opposition, when a planet appears opposite the Sun in our sky. Mars rises shortly after sunset when the New Year begins, and by the night of opposition on January 7 it comes up before the Sun goes down. Mars is highest in the sky – practically overhead — at approximately midnight and descends in the west before dawn.

Mars is easy to recognize despite the many brilliant stars in the winter Milky Way. Simply look toward Gemini the Twins, high in the eastern sky in mid-evening. Mars is brighter than Castor and Pollux, the two brightest stars in Gemini, and appears much more orange in color. In fact this month Mars is nearly as bright as the brightest star in the sky, Sirius in the winter constellation Canis Major. Compare the magnitude of Sirius (–1.5) with Mars, which shines at –1.4 on January 15. Like all stars, Sirius twinkles, while Mars shines steadily. On the night of opposition, Mars crosses the sky in the company of the Moon. The Moon is Full early the following morning. Watch Mars and the Moon draw closer together throughout the night of January 7/8.

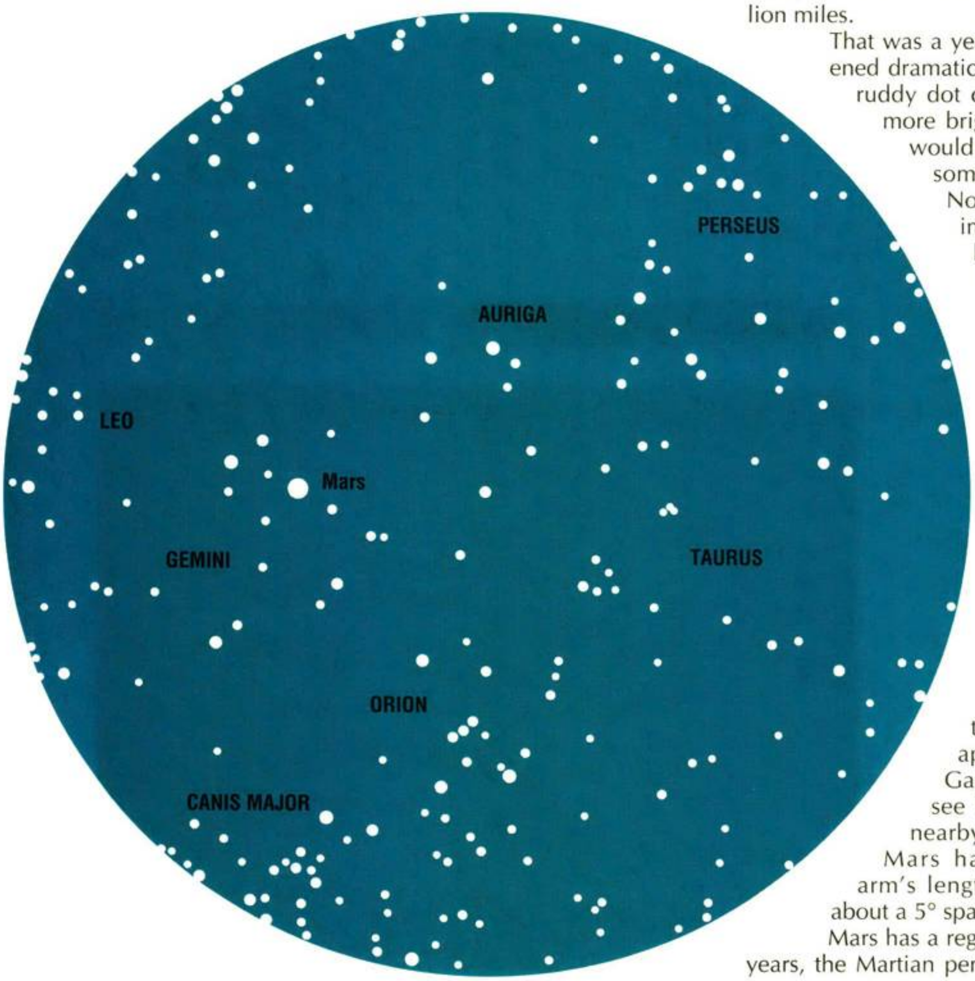
Oppositions of Mars come about every two years, but not all Martian oppositions are the same. The best ones come when Mars is closest to the Sun (called perihelion) in its two-year orbit. Mars reached perihelion last May 17. It has been moving outward since then, getting increasingly farther from the Sun in its rather elliptical orbit. It will reach aphelion — its farthest point from the Sun — this April 25. Meanwhile, we are closest to the Sun in our more circular orbit on the night of January 3/4. When we pass between Mars and the Sun this month, our two worlds are separated by about 58 million miles. During the 1988 opposition of Mars, the Martian perihelion and opposition more nearly coincided, and Mars and Earth were separated by only about 35 million miles.

That was a year not to be forgotten, when Mars brightened dramatically over a period of weeks to become a ruddy dot of flame in the night sky. It shone even more brightly than the planet Jupiter. But as fate would have it, in that year Mars was in Pisces, somewhat low in the sky as seen from the Northern Hemisphere. This year Mars is riding far northward in the sky, in an excellent place to be observed by stargazers in the United States and Canada.

Since Mars is now moving farther from the Sun, we are closer to the planet — by about 117,000 miles — on January 3 than on January 7. And yet Mars always shines most brightly for the year on the night of opposition itself. Its brightness stems not only from its nearness to Earth but also from the fact that at opposition, we see it 100 percent illuminated, a "Full Mars." Throughout the month you might watch for Mars' retrograde motion. Normally planets move across the sky from west to east, in so-called direct motion. But near times of opposition when a planet like Mars is overtaken in its orbit by Earth, the planet appears to move east to west in the sky. Gauge the amount of retrograde motion you see by comparing Mars' position to that of nearby stars. You can measure distances that Mars has moved by holding your hand at arm's length and making a fist — that gives you about a 5° span on the sky.

Mars has a regular cycle of oppositions. About every 17 years, the Martian perihelion and opposition come around the

**THE BRIGHT STARS OF WINTER** make January's evening sky a beautiful sight to behold. Among the easiest constellations to find are Orion, Auriga, Taurus, Gemini, and Canis Major.



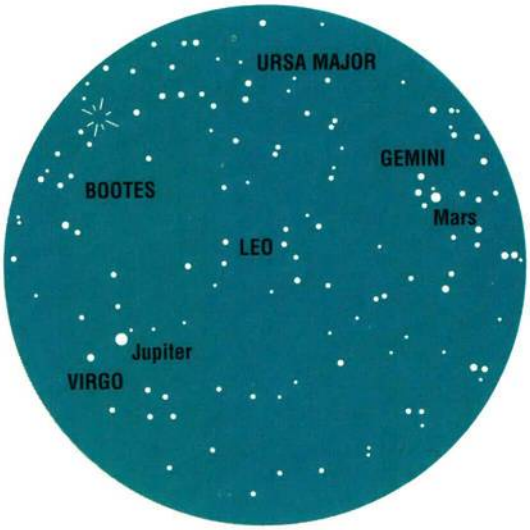
same time, and the planet appears fantastically bright for a few weeks. The next close Martian opposition will come in August 2003.

## VENUS REACHES GREATEST ELONGATION

Venus is the brightest planet, far outshining all other celestial objects with the exception of the Sun and Moon. Yet Venus has a more reserved side. I first began to notice it low in the evening twilight in early September. It remained fairly low in the sky throughout last autumn. Only last month did it begin to appear noticeable enough that people glancing casually up to the west after sunset might have commented to their companions about the brightness of the "evening star."

This month Venus reaches greatest eastern elongation, its greatest apparent distance from the Sun for this evening apparition. It is 47° east of the Sun on January 19. On that evening, you'll find the planet in the west-southwest after sunset. It shines brilliantly at magnitude −4.4 and sets fully four hours behind the Sun. The wondrous planet Mars — ascending in the east during these same hours — looks pale in contrast to Venus. In fact Venus is so bright that under a really dark sky it casts shadows on the ground below, especially on snow or other white surfaces. Can you detect a Venusian shadow?

Early stargazers called Venus the planet of love and Mars the planet of war. Were particularly bright oppositions of the War Planet seen as a portent of coming conflict? If so, then this year's milder sort of Martian opposition might be taken as a kinder sign. With the Love Planet shining brightly and prominently on the other side of the evening sky, the ancients might have predicted a peaceful year ahead.



## JANUARY'S PLANETS

**Saturn** shines in the evening twilight. It is closely below Venus when the month begins, fairly inconspicuous at magnitude 0.4. In the course of this month, Saturn slips into the twilight glare. It will be in conjunction with the Sun next month.

Shining brilliantly in the west-southwest after sunset is **Venus**, at magnitude −4.4. You can't miss it: Venus is the brightest planet there. Its greatest apparent distance from the Sun for this evening apparition comes January 19. Look for Venus on the evening of January 26, when it appears right next to the returning young Moon.

**Mars** is at its brightest and most prominent now. Martian opposition comes on January 7. The planet ascends in the east in the evening and heads down in the west before dawn. At peak brightness, it shines at magnitude −1.5 in the constellation Gemini. Enjoy the many other bright stars that also lie in this vicinity of the winter sky. On the night of opposition, Mars appears near the Moon.

**Jupiter** rises after midnight when the month begins, but as the month progresses it moves into the evening sky. The planet is in the constellation Virgo. If you look east before midnight on the night of January 13/14, you will see Jupiter rise in the company of the Moon. The Moon travels with the planet until dawn. The planet begins retrograde, or westward, motion on January 29, a sign of Jupiter's coming opposition.

**Mercury** cannot be seen this

**THE QUADRANTID METEORS** will peak in the early morning of January 4, when observers can expect to see as many as 80 meteors per hour. The early morning hours will be unhampered by moonlight.

James R. Westlake, Jr.

month. It is behind the Sun, in superior conjunction, on January 23. It will return to the evening sky next month.

## THE STARRY SKY

The mighty Hunter in the constellation Orion is the most noticeable of star figures, high in the southeast during January evenings. Orion isn't the largest constellation, ranking only twenty-sixth in total sky area. Yet there is something about this pattern of stars that conveys the impression of greatness. Perhaps that's because Orion's pattern of stars is so well defined or because the Hunter is studded with more bright stars than any other constellation figure.

Who can ignore Betelgeuse, a somber red star in the upper-left corner of the rectangle that marks the Hunter's body? This star is the red supergiant that marks the Hunter's right shoulder. Astronomers have known for the past 15 years that Betelgeuse is surrounded by an immense shell of matter. The shell has a radius of about 1.6 trillion miles — 400 times larger than the radius of our solar system!

Then there's Rigel — diagonally opposite Betelgeuse in the rectangular body of Orion — a blue-white, hot, young star. Rigel is one of the most massive stars in the Galaxy, with a life on the main-sequence that's destined to be glorious but brief. It'll burn through its entire hydrogen supply in only a few million years. Rigel appears a little brighter than Betelgeuse. It marks the left knee of the Hunter.

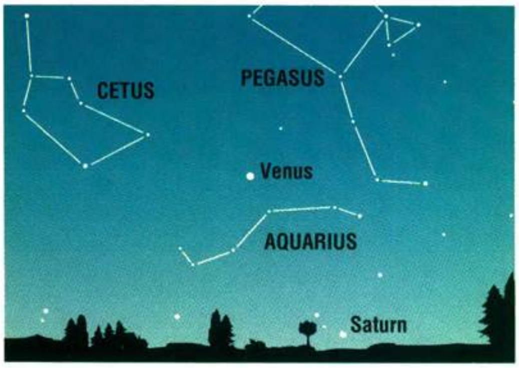
Betelgeuse and Rigel draw the eye, but the sharpest feature in Orion is a short, straight row of three medium-bright stars. This is Orion's Belt. A curved line of stars extends from the Belt, representing Orion's Sword. The eye can easily pick out a misty star within the Sword of Orion. Called M42, the Orion Nebula, it is located in the middle of Orion's sword.

The Orion Nebula appears to the eye as a fuzzy star. Binoculars show more haze and a tinge of green. A 6-inch telescope reveals sinuous rivers of greenish haze. Telescopes reveal a little grouping of at least four stars known as the Trapezium. They are O, B, and A stars, extremely hot, blue-white suns, whose energy causes the Orion Nebula to glow.

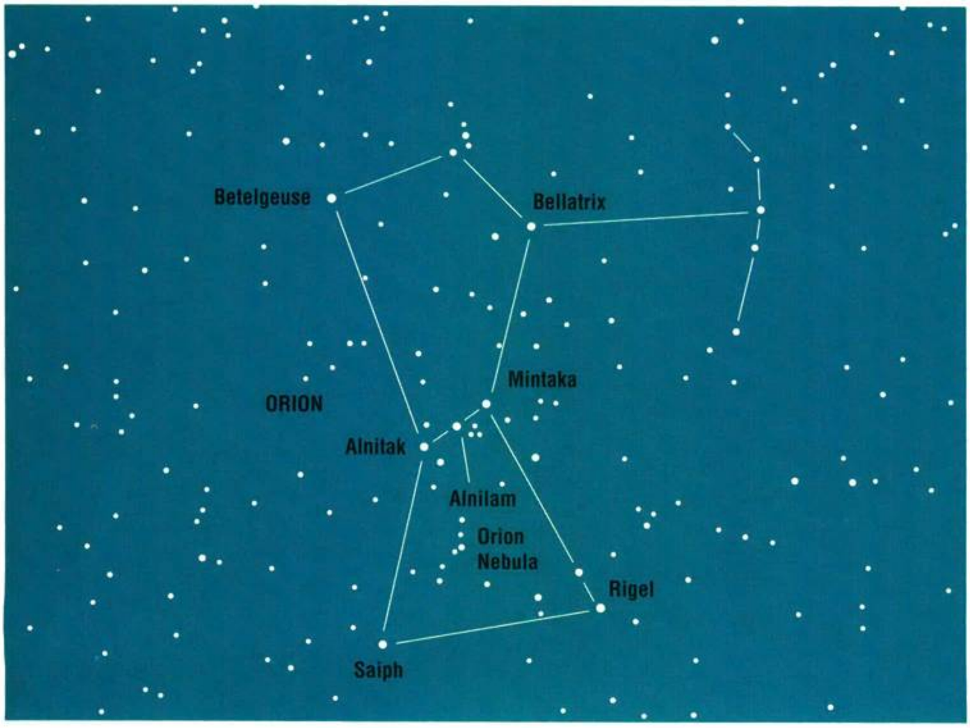
The Orion Nebula marks the location in our sky of a huge dark cloud in which many new stars are forming. These stars cannot be seen in visible light, but they have been studied at other wavelengths. No one knows how many new stars may eventually emerge from this region of the sky, but thousands may appear in time.

Imagine traveling millions of years into the future and seeing the Orion Nebula not as a hazy cloud, but as an open cluster of young stars. Some echo of this transitory nature might be heard in a tribute to the Orion Nebula that occurs in Tennyson's "Merlin and Vivien":

*A single misty star*
*Which is the second in a line of stars*
*That seem a sword beneath*
*a belt of three,*
*I never gazed upon it but I dreamt*
*Of some vast charm concluded*
*in that star*
*To make fame nothing. . . .* □



**VENUS IS THE BRIGHT "STAR"** in the west after the Sun sets. It reaches greatest eastern elongation on the 19th, when it will be a whopping 47° away from the Sun.



**BRILLIANT ORION** is the favorite winter constellation for many observers. Its bright stars Betelgeuse and Rigel provide an unusual color contrast of ruddy-orange and blue-white.

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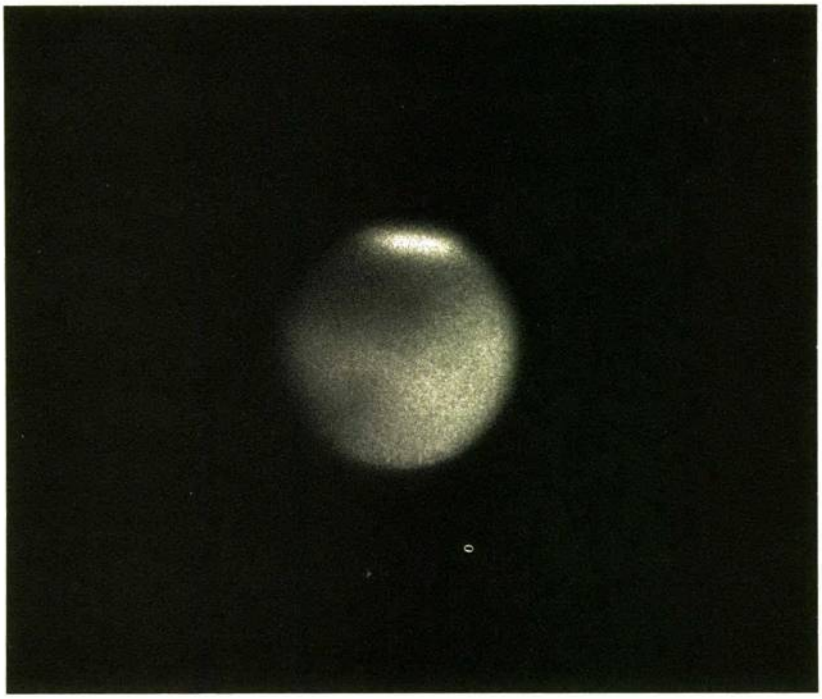
*Deborah Byrd is a writer and producer of the daily "Earth and Sky" radio series. It now can be heard on over a hundred radio stations.*

by Jeff Kanipe

## MARS AT ITS BEST


Kim Zussman

**MARS REACHES OPPOSITION** on January 7, when it shines at magnitude –1.5 and spans nearly 15". This month provides the best opportunity to see Mars since 1990.

**Mars** reaches opposition on January 7. Most of the time, Mars presents a small rust-colored disk with vague surface features. But at opposition the planet's brightness and size grow so that observers using small telescopes can see a great deal of detail on the planet's surface. A 3-inch to 6-inch scope shows the most prominent features on the Martian disk. Telescopes of 10-inches and larger aperture show significantly lower contrast features as the planet reaches opposition. You'll want high magnifications to see these features.

Some oppositions are clearly better than others. If Mars is at or near perihelion at the time it reaches opposition, the distance between the Red Planet and Earth can be as little as 56 million kilometers (35 million miles) and an astounding amount of detail is visible (providing the planet is well placed in the heavens). The last great "perihelic opposition," as this alignment is called, occurred in September 1988. The next great perihelic opposition will be in August 2003.

For this opposition, Mars lies nearly 94 million km (58 million miles) from Earth at its closest point. Although this is not ideal, things could be worse. Mars' disk will be even smaller for the next two oppositions. Not until May 1999 will Mars' disk appear larger than it does this year.

Fortunately, this year's close approach offers one distinct advantage. Opposition occurs just eighteen days past the winter solstice, when Earth's Northern Hemisphere is tilted at maximum away from the Sun. At that time, Mars will be well north of the celestial equator between declinations +23° and +26°, putting it practically overhead for observers in the United States and Canada. With this northerly declination, Mars will be riding high in the sky free of the murk of the atmosphere and poor seeing conditions around the horizon. This location should allow observers with telescopes to use high magnification to ferret out surface features.

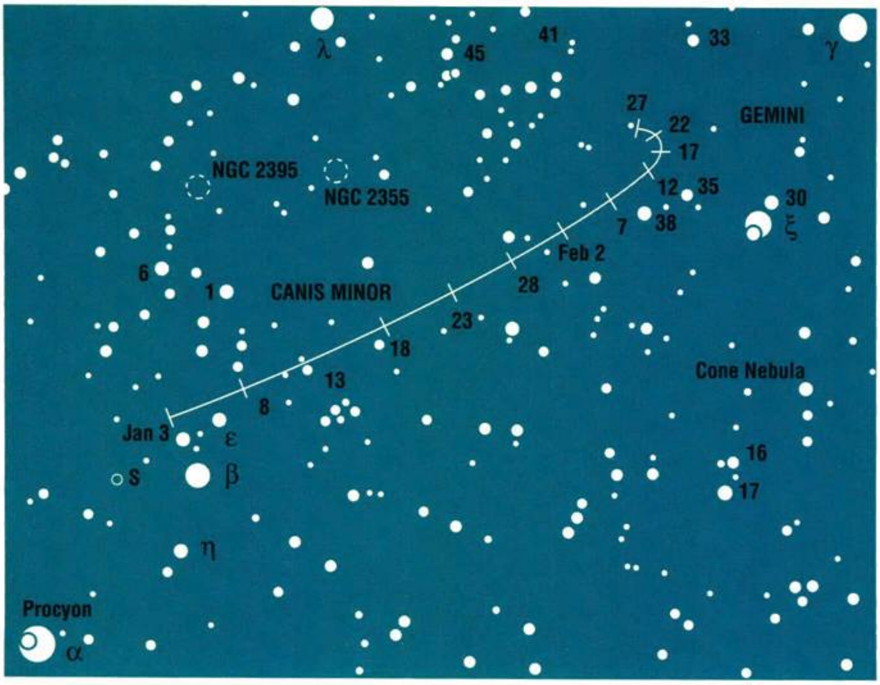
With a maximum apparent disk size of nearly 15", observers should have no trouble identifying prominent Martian features. Use the highest magnification seeing conditions will allow — on the order of 150x for 3- to 5-inch telescopes, 250x for 6- to 8-inch ones, and 300x for those in the 10- to 12-inch range. Orange and red filters may also help enhance the contrast in the dark areas, but don't rely on them to do all the work.

Mars' northern polar cap will be the bright white dot on the limb extended toward Earth. That's easy to see, even in small telescopes. The polar cap will shrink over the coming weeks of Martian spring, but because Mars is heading toward aphelion in April, the polar cap probably won't waste away as quickly as it did in 1988 when the planet was near perihelion.

Observers should have no trouble making out dark equatorial features on those nights when Earth's atmosphere is calm. Look for the funnel-shaped plain Syrtis Major, whose southern extent is broad and dark. Off to the west (using the Martian globe), is Sabaeus Sinus, an elongated feature that narrows toward the west but then broadens again into a darker nodule called Meridiani Sinus. During moments of good seeing, observers with 8- or 10-inch telescopes might detect a two-horned extension pointing northward from this feature.

Margaritifer Sinus is another wedge-shaped plain west of Meridiani Sinus. And still farther west are the mottled plains of Mare Erythraeum, Aurorae Sinus, and the distinctive "Eye of Mars," known as Solis Lacus. Contrasting with these dark regions are the bright dust bowls, like the Hellas basin, in the temperate southern latitudes due south of Syrtis Major, and Isidis Regio, which forms the northeast boundary of Syrtis Major.

Patience is a virtue when observing Mars. Even if the image of Mars is boiling like a three-minute egg in your scope's eyepiece, keep your eye on the disk. Very often the air will suddenly steady, providing a momentary opportunity of good seeing. Contrasting features on the planet will suddenly jump out with amazing clarity.



**ASTEROID 18 MELPOMENE** reaches opposition on January 10, when it glows at magnitude 9.0 and lies in the constellation Canis Minor. Use a telescope to track its motion against the background stars.

## COORDINATES FOR MELPOMENE

| Date | R.A. (2000.0) | Dec. |
|---|---|---|
| January 3 | 7h28.7m | + 9°18' |
| January 8 | 7h23.2m | + 9°51' |
| January 13 | 7h17.8m | +10°27' |
| January 18 | 7h12.6m | +11°06' |
| January 23 | 7h07.8m | +11°46' |
| January 28 | 7h03.6m | +12°27' |
| February 2 | 7h00.0m | +13°08' |
| February 7 | 6h57.2m | +13°48' |
| February 12 | 6h55.3m | +14°26' |
| February 17 | 6h54.1m | +15°03' |
| February 22 | 6h53.8m | +15°37' |
| February 27 | 6h54.4m | +16°09' |

## *VENUS IN THE EVENING SKY*

The planet **Venus**, which has been making an agonizingly slow climb into the evening skies since last summer, finally reaches its greatest eastern elongation from the Sun January 19. This is one of the more favorable elongations of Venus in over a year: 47°. (Venus' maximum possible elongation is around 48°.) Factor in its 24" angular diameter, a phase of 50 percent (appearing half lit), and a –4.4 magnitude, and you have an object that clearly dominates the western evening sky throughout January.

As the year progresses, Venus heads toward inferior conjunction, when it will be a more compelling object in the telescope. Its apparent angular diameter grows as it nears Earth and yet its phase decreases as it swings in toward the Sun. Between now and then, draw a bead on this cloud-enshrouded planet, but do it in the late afternoon or early evening before it gets dark. After dark, the planet's disk is so dazzling against the black sky that it is impossible to see any detail (what little there is). Even the phase is hard to discern. But in a low-contrast sky, such as bright twilight or, even better, full daylight, the phase looks more distinct; the disk more hard-edged. Use binoculars to locate Venus in the west before sunset. If you observe after dark, try using a deep-blue or violet filter to reduce glare. Some planet observers even recommend observing Venus through thin high clouds. Try it and see.

Look along the terminator for mottling or irregularities. Because they can appear and disappear so quickly, these features are most likely caused by convective air cells in Earth's atmosphere. If the seeing is especially good, look for gray or dusky areas that darken toward the terminator. In fact, look for any unusual effects, such as bright spots, shading or, if you're observing during the crescent phase, changes in the brightness of the cusps. The fun comes in deciding if what you are seeing is real or illusion.

## *JOVIAN SHADOW PLAY*

Giant **Jupiter** reaches quadrature January 3. Those of you who read this column last May will recall that when this geometry occurs, Jupiter can be a fascinating planet to follow through the telescope. Unfortunately, this time the planet doesn't rise until after midnight, so you'll have to either set your alarm for the wee hours or play a protracted game or two of Monopoly with a willing friend before going outside.

Quadrature is an aspect of the superior planets alone and is akin to, but not the same as, greatest elongation for the inferior planets. It occurs when a line drawn from Earth to the Sun forms a right angle with a line drawn from Earth to a planet — be it Mars, Jupiter, or any outer planet. Not surprisingly, quadrature, like an elongation or opposition, tells us approximately where we can find the planet in the sky. There are two aspects of quadrature. In the case of eastern quadrature, the outer planet is overhead at sunset; at western quadrature, it is overhead at sunrise, which is the situation for Jupiter this month.

This is the time to break out the high-magnification eyepieces and zoom in on the disk of the planet. Discern a phase? Yes! Jupiter does exhibit a slight phase angle when at quadrature. It's difficult to see but still possible to detect if you look carefully.

Jupiter's moons also put on their best show at quadrature. Being lit more from the side than normally, the planet casts its shadow at an extreme angle to one side of the globe. Therefore, when Jupiter's satellites reappear out of the planet's great shadow, they do so farther from the disk, making these eclipses easier to see.

Be on the lookout also for Jupiter's transiting Galilean moons. These are best seen at the beginning or end of the transit, when the moons stand out bright against the planet's dusky limb. It is difficult but not impossible to track these moons across the disk of the planet. You just need a good telescope (at least a 3-inch), high magnification, and good seeing conditions. Given these factors, the main problem with seeing any of the four moons as they traverse Jupiter's disk is the planet's glare. The moons, when seen against the dark background of space, are quite bright. But when they pass in front of the planet they suddenly become washed out dots and may be lost among similarly colored cloud zones. Easier to see are the moon's dark shadows projected on to the planet's disk. In fact, these are sometimes mistaken for transiting moons. Ganymede, because of its large size and dull surface, is perhaps the easiest of the four moons to observe transiting (although, Callisto, having the darkest surface material of the Galilean moons, may be easier to see when it passes over Jupiter's lighter-colored regions). Under good seeing conditions, an observer with an 8- or 10-inch telescope may even detect Ganymede's blanched ocher hue as the planet makes its way over a bright zone.

It often helps to know which direction the moons are moving in order to anticipate an event. In a telescope like a refractor or an SCT, which inverts the image, the satellites orbit from right to left, i.e., in the planet's westward direction of motion. When the moons are on the far side of the planet, however, they move from left to right. You can usually detect unmistakable motion of the moons with respect to one another within about fifteen minutes.

Donald C. Parker

**VISIBLE LOW IN THE SOUTHWEST** in the evening sky, Saturn and its rings will be visible early in the month, below the much-brighter planet Venus.

## ASTEROIDS IN THE EYEPIECE

In early January, the asteroid **3 Juno** is still a fairly bright object at magnitude 7.8. After all, it was only at opposition on December 28. Bear in mind, however, that it is now entering eastern Orion where there lies a plentitude of stars of similar magnitude. For the entire month, Juno edges toward Betelgeuse as it makes its retrograde loop; by February it arcs back to the east.

On January 1, Juno is located in a region a little over a degree due west of 77 Orionis. By the 6th, it lies farther northwest of that position, in the same field of view with a pair of 6th- and 7th-magnitude stars. On the 18th, it skirts past a 6th-magnitude double star some five degrees southeast of Betelgeuse. Juno closes in on 66 Orionis by month's end, coming closest to that star on the 29th.

Die-hard asteroid observers will want to look for **18 Melpomene**, which comes to opposition January 10 in Canis Minor. It peaks around magnitude 9. On that evening, the asteroid is northwest of Beta Canis Minoris. Make a sketch of the field stars carefully, (there are a lot of the same magnitude) and check the area a few hours later. Being closest to Earth at this time, the asteroid is moving fairly rapidly, so some movement should be discernible. Enjoy your search for Melpomene on these winter nights! ☐

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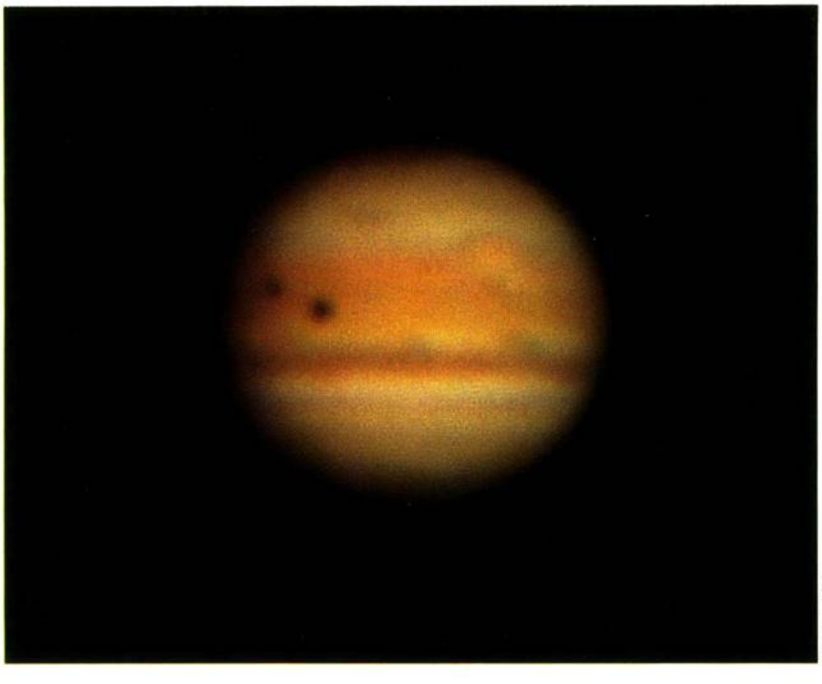
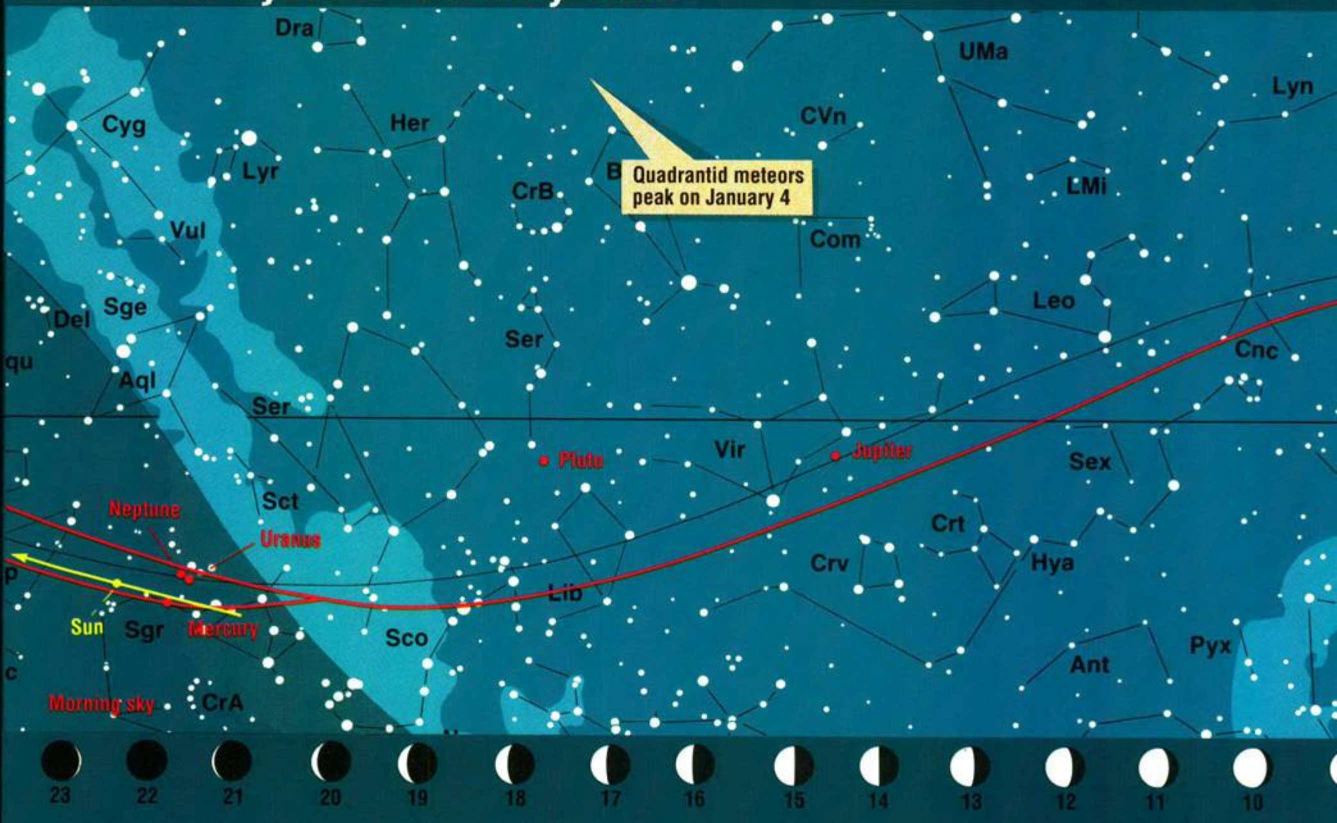
*Jeff Kanipe is the editor of* Star Date *Magazine, which is published by McDonald Observatory at The University of Texas at Austin.*

**SHADOW PLAY ON JUPITER** will entertain you this month as the planet reaches quadrature. Watch for transits and eclipses of the Jovian satellites.



Stephen Keene

# The Solar System   January 1993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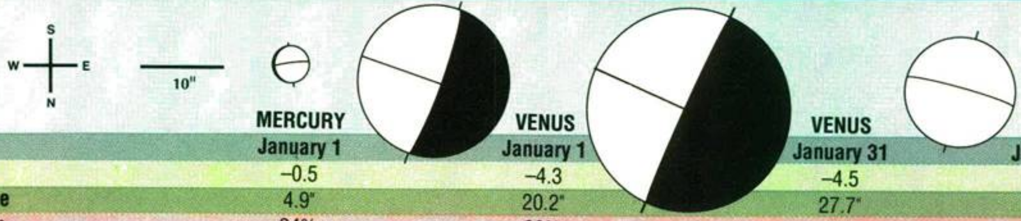
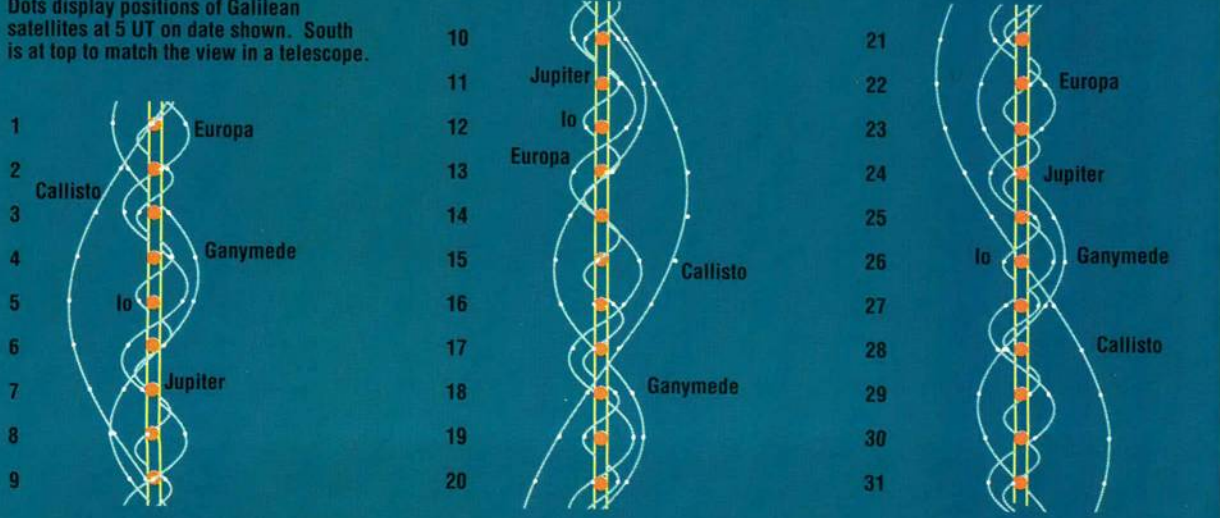
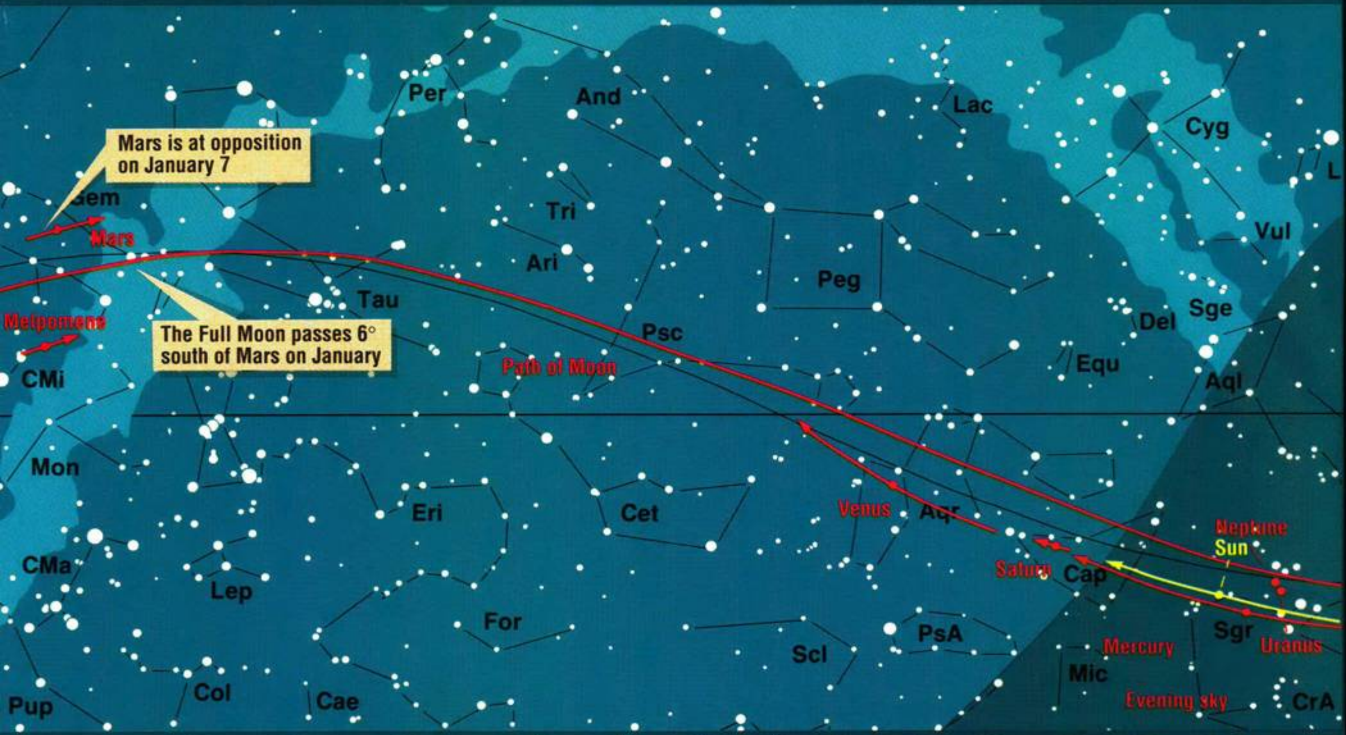


| Planet | MERCURY | VENUS | VENUS | MARS |
|---|---|---|---|---|
| Date | January 1 | January 1 | January 31 | January 15 |
| Magnitude | –0.5 | –4.3 | –4.5 | -1.4 |
| Angular Size | 4.9" | 20.2" | 27.7" | 14.6" |
| Illumination | 94% | 60% | 45% | 100% |
| Distance (AU) from Earth | 1.361 | 0.825 | 0.603 | 0.640 |
| Distance (AU) from Sun | 0.461 | 0.723 | 0.719 | 1.617 |
| Right Ascension (2000.0) | 17h49.6m | 21h58.2m | 23h50.0m | 7h07.2m |
| Declination (2000.0) | –23°51′ | –14°03′ | +0°13′ | +25°40′ |

## Jupiter's Moons

Dots display positions of Galilean satellites at 5 UT on date shown. South is at top to match the view in a telescope.




Per
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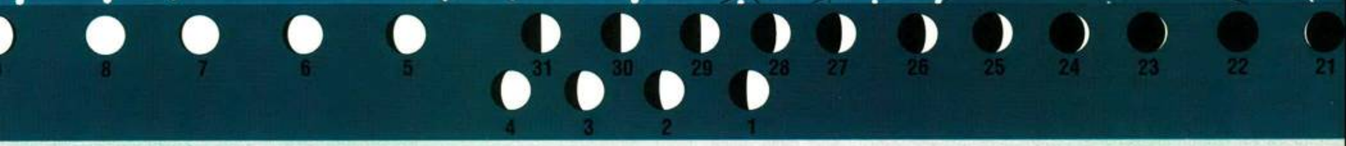
Cet
Venus
Aqr
Neptune
Sun
CMa
Saturn
Cap
Lep
For
Sgr
Scl
PsA
Mercury
Uranus
Mic
Pup
Col
Cae
Evening sky
CrA

Mars is at opposition on January 7

The Full Moon passes 6° south of Mars on January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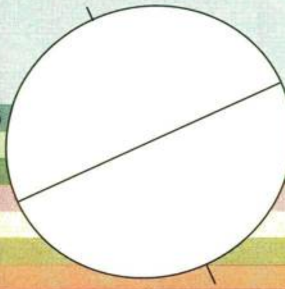
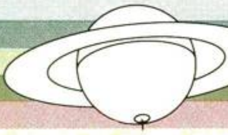
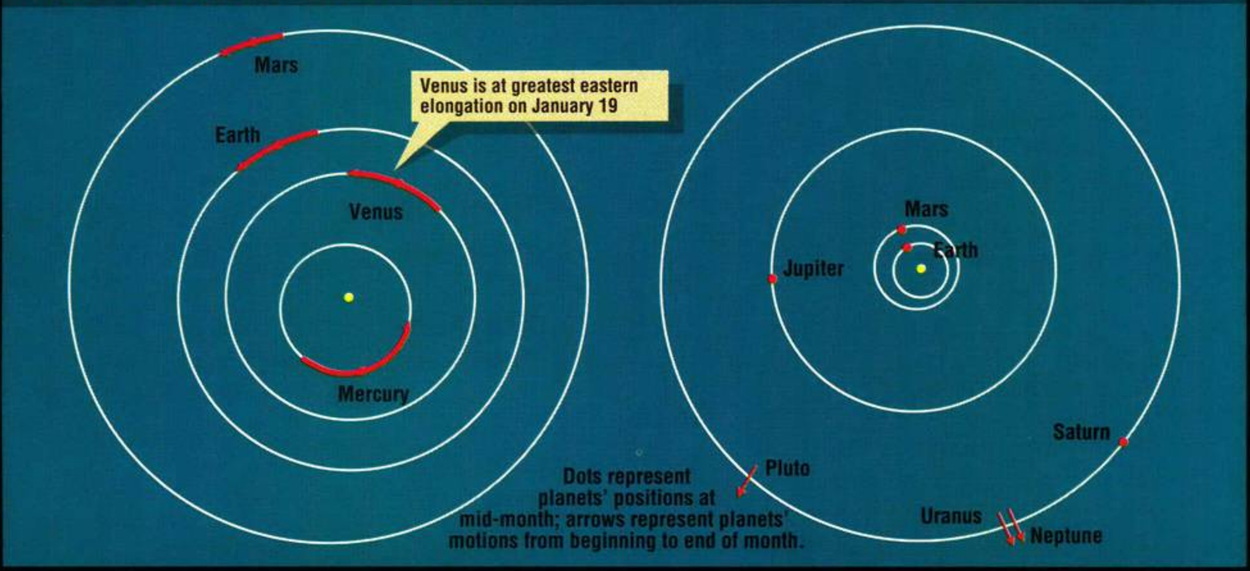




| JUPITER January 15 | SATURN January 15 | URANUS January 15 | NEPTUNE January 15 | PLUTO January 15 |
|---|---|---|---|---|
| −2.1 | 0.7 | 5.8 | 8.0 | 13.8 |
| 37.9" | 15.4" | 3.4" | 2.2" | 0.1" |
| 99% | 100% | 100% | 100% | 100% |
| 5.184 | 10.759 | 20.552 | 31.166 | 30.187 |
| 5.449 | 9.861 | 19.575 | 30.188 | 29.721 |
| 12h55.4m | 21h23.0m | 19h20.7m | 19h21.7m | 15h44.6m |
| −4°27' | −16°25' | −22°34' | −21°26' | −5°10' |

## The Planets in Their Orbits


Mars
Earth
Venus
Mercury
Mars
Earth
Jupiter
Saturn
Pluto
Uranus
Neptune

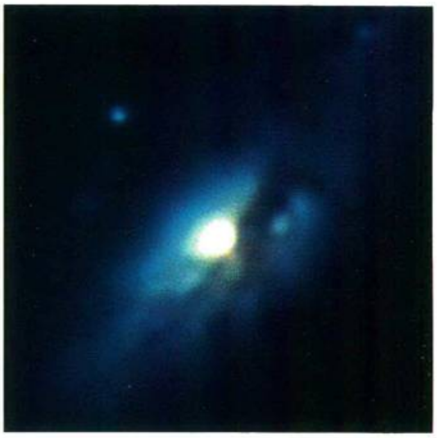
Venus is at greatest eastern elongation on January 19

Dots represent planets' positions at mid-month; arrows represent planets' motions from beginning to end of month.

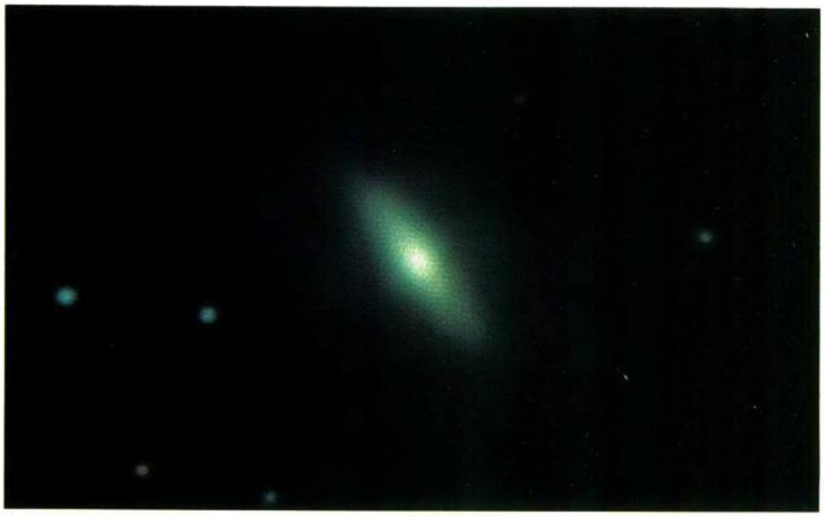
# THE WONDERFUL WORLD OF GALAXIES

Galaxies come in a dizzying number of shapes and sizes and each is a fundamental building block of the universe.

by David J. Eicher



Spiral galaxies show a variety of forms, from the barred arms of galaxy NGC 1365 (opposite page) to the dusty, distorted nucleus of NGC 2146 (right) to the diffuse, ring-encased structure of NGC 2685 (below).



Photos courtesy Rudolph Schild, Harvard-Smithsonian Center for Astrophysics

Chuck Vaughn

On a simple level, galaxies are pretty straightforward things, collections of stars, gas, and dust drawn and held together by gravity. Only the immense distances between galaxies keep them from endlessly combining and growing far beyond their present physical sizes. Astronomers study them every night, have understood their basic nature since 1924, and feel pretty comfortable with how galaxies work.

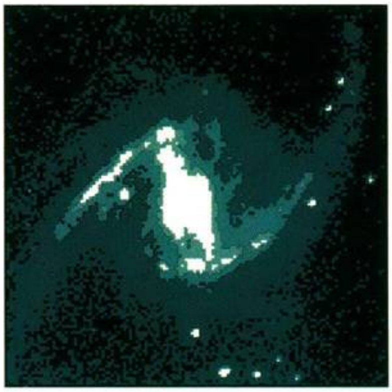
Yet as we look closer at galaxies, we discover a fascinating, complex world that exists within each of them. The environment within each galaxy, the galactic landscape, is unique and presents the inhabitants of these galaxies — whether they be beings, stars, gas clouds, or spiral arms — with an individual set of circumstances. Likewise, the space that surrounds each galaxy is unique, sometimes empty for thousands of light-years, sometimes filled with material from galaxies in contact with each other.

To appreciate the great variety individual galaxies offer, we need to look at a selection of these "island universes." Take NGC 2146, for example. Lying at a distance of 45 million light-years toward the constellation Camelopardalis, this magnitude-10.5 barred spiral is a springtime favorite for backyard galaxy watchers armed with small telescopes. The galaxy appears as an elongated patch of light measuring about 6' by 4', with a bright center that is bisected by a dark lane.

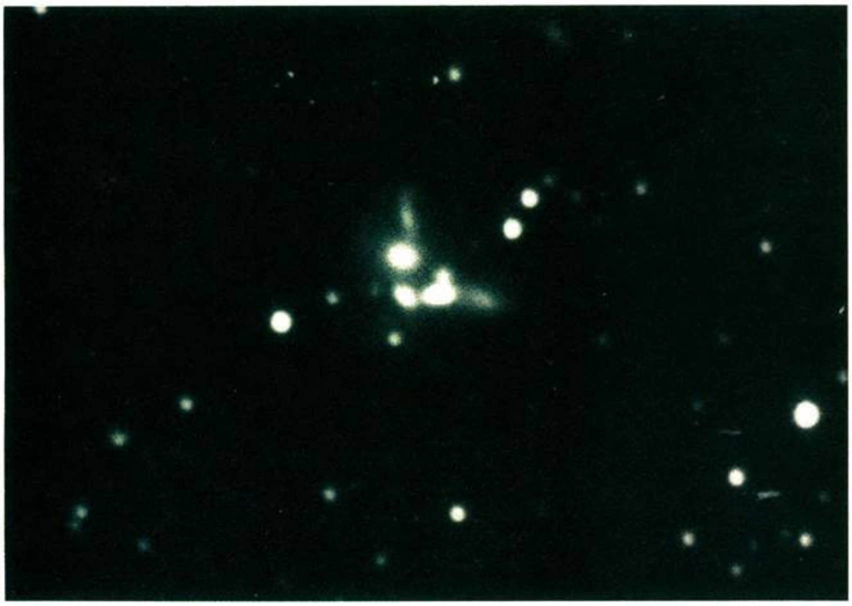
Astronomers who view NGC 2146 in great detail, however, see a very different picture. The galaxy is strongly distorted, showing an amorphous set of spiral arms. What little structure does show in the arms suggests the galaxy was twisted in the distant past. The galaxy's nucleus is extremely bright on one side and not very bright on the other. A fat dust band conceals the inner sanctum of this galaxy's core. Most of the galaxy appears yellowish, indicating the stars are quite old, although a few bluish regions of star formation pepper the dust lane.

Even more unusual is the case of NGC 2685 (distance = 42 million light-years), a lenticular (lens-shaped) galaxy located in Ursa Major. In describing this odd character, McDonald Observatory astronomer James Wray writes, "Many galaxies are peculiar, but few are as uniquely peculiar as NGC 2685." Backyard observers know this object as an 11th-magnitude galaxy whose elliptical shape spans 5.2' by 3.0'. The main body of this galaxy has a relatively high surface brightness and so is relatively easy to see in small telescopes. What backyard observers cannot see is an extremely faint ring of luminous material encircling the galaxy's nucleus at a right angle relative to the galaxy's elongation. The existence of this ring, perched high above and below the galaxy itself, is baffling to astronomers studying normal galaxies. The structure in NGC

Preston S. Justis



*Galaxy groups are a microcosm of the universe at large. The NGC 474 group in Pisces (opposite page) holds lenticulars and spirals. The Perseus Galaxy Cluster (above) is dominated by central elliptical galaxies. Seyfert's Sextet in Serpens (below) holds spirals.*



K. Alexander Brownlee

Kim Zussman

2685 may be the result of an ancient collision between two galaxies that subsequently merged. The twisted shape of NGC 2146 may also be the result of a past collision with another galaxy.

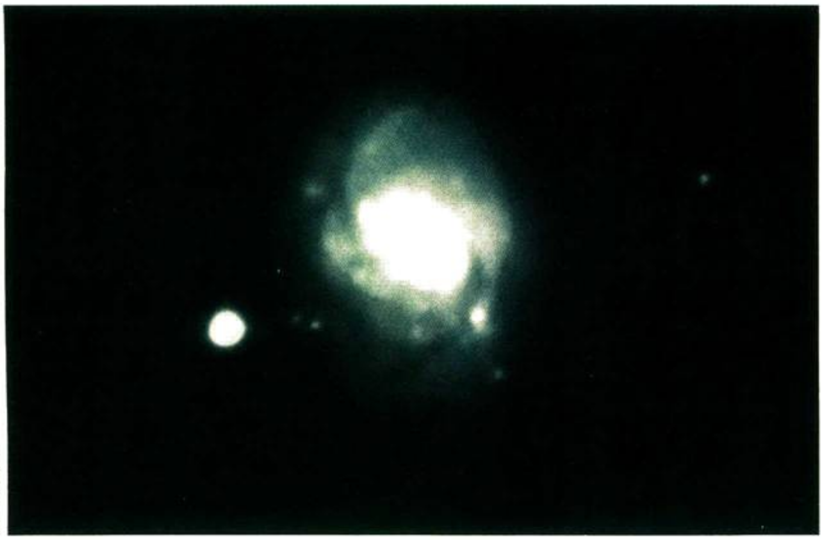
Not all galaxies are so distorted, however. The magnificent barred spiral NGC 1365 in Fornax (distance = 65 million light-years) is a classic example of its type. Glowing at magnitude 9.5 and measuring 9.8' by 5.5', NGC 1365 is large and bright enough to see in binoculars as well as in a 6-inch telescope. The galaxy's most distinctive features are a bright central region, a well-defined bar extending some 2' on either side of the nucleus, and graceful spiral arms that arc away from the bar in shapes like giant scythes. The spiral arms of NGC 1365 are apparently thriving, as bluish clumps and knots betray the presence of star formation within them. Yellowish light from the galaxy's arms and center comes from older stars that will live much longer than the hot blue stars currently forming. Many astronomers now believe interactions between galaxies can trigger bursts of star formation like this and are important mechanisms in revitalizing galaxies.

Galaxies like NGC 2146 and NGC 2685 may have been influenced by other galaxies in the distant past. But other galaxies are encountering galaxies as we see them now. In fact large numbers of galaxies observed from Earth exist in groups and clusters wherein members are separated by only a few thousands of light-years — or are actually colliding.

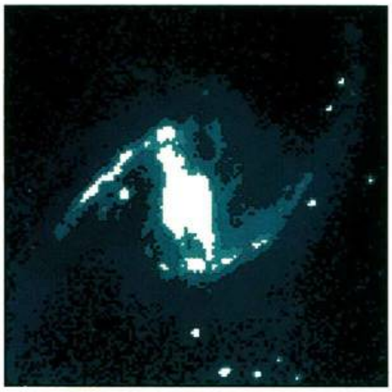
Take the case of the NGC 474 galaxy group in Pisces (distance = 100 million light-years). Three bright members of this group — NGC 467, NGC 470, and NGC 474 — lie separated by just a few arcminutes on our sky. NGC 467 (magnitude 11.9, size 2.4' by 2.3') and NGC 470 (magnitude 11.9, size 3.0' by 2.0') are lenticulars and spirals that appear as bright fuzzballs in amateur telescopes. NGC 474 is a magnitude-11.1 lenticular galaxy that spans 7.9' by 7.2'. NGC 470 shows an extremely faint and large shell of material on long-exposure photos. NGC 474 has a weakly defined set of spiral arms that contain three or four clumps of star-forming regions. In the NGC 474 galaxy group, evidence of interaction is subtle at best.

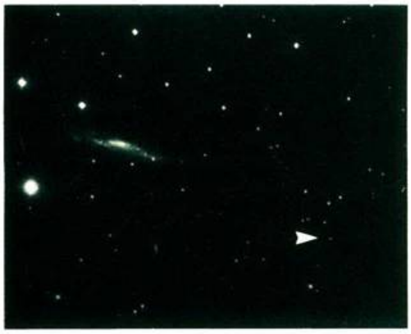
Another fine example of such a group is the Perseus Cluster of galaxies, dominated by the massive ellipticals NGC 1275 and NGC 1270 (distance = 240 million light-years). Here again the evidence of interaction you might get from staring at a photo is hardly overwhelming, but astronomers know that NGC 1275 — the central supergiant elliptical galaxy of the group — is a so-called cD galaxy. The galaxy has a central black hole, an object that is slowly devouring smaller galaxies passing by it.

Other galaxy groups show more direct evidence of interaction, as they have been caught in the act of



Kim Zussman





K. Alexander Brownlee

*Oddball galaxies include NGC 660 in Pisces (opposite page), a dusty barred spiral whose distorted shape implies an ancient galactic encounter. The Seyfert galaxy M77 in Cetus (above) shows a bright, energetic nucleus. Maffei I in Cassiopeia (below) is a large, Local Group galaxy that is heavily obscured by dust in the Milky Way. The twin quasar 0957+561 (left, arrowed) lies near the spiral NGC 3079. The quasar's double image is an optical illusion.*

James R. Foster

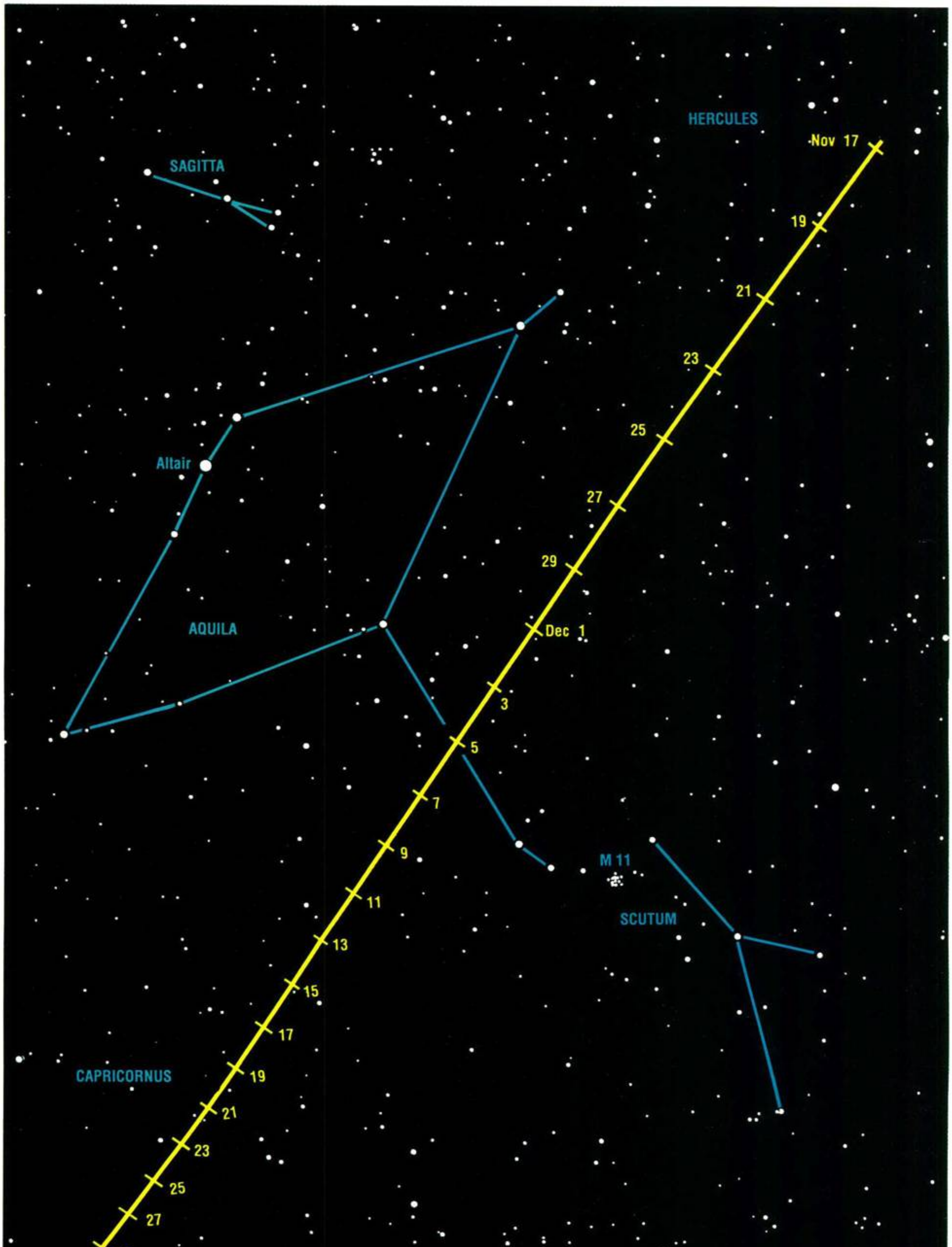
Kim Zussman

being physically entangled. A spectacular example of this type of group is Copeland's Septet (distance = 400 million light-years), a collection of seven barred spirals, spirals, and lenticulars in Leo. (At magnitude 14, the brightest galaxy is the spiral NGC 3753.) In Copeland's Septet (named for the astronomer who studied the group) we see the three brightest galaxies in contact with each other and faint wisps connecting two additional pairs of objects. The physical contact is more severe in Seyfert's Sextet (NGC 6027, distance = 200 million light-years) in Serpens. This group consists of six spirals virtually stacked on top of each other.

Some galaxies push the concept of strange to the limits of the known universe. The most unassertive galaxy known to astronomers is Maffei I, a large spiral that is one of the closest such galaxies to us (distance = 3 million light-years). This object would be one of the most spectacular in the sky were it not for a cruel deal of the deck which placed it behind Cassiopeia's thick blanket of Milky Way dust. As it is, this cosmic giant is so obscured by intervening dust that it is barely visible in the largest backyard telescopes.

Perhaps the oddest extragalactic object of all visible in backyard scopes is the double quasar 0957 +561 in Ursa Major. Although it appears like a 17th-magnitude double star (and is thus visible only in the largest amateur scopes), this object is a quasar lying at a distance of 6.3 billion light-years. It appears double because somewhere along that 6.3 billion light-years a massive galaxy acts as a gravitational lens and splits the quasar's image into two parts. This makes it one of the most unusual objects known to astronomers. (Incidentally, the bright galaxy NGC 3079 lies nearby and is a convenient starting point for finding the quasar; see the photo at left.)

So you see that the universe of galaxies is an incredibly varied mixture of the normal, the peculiar, the reclusive, and the gregarious. Whether you haul out your scope and pick off distant spirals or simply enjoy looking at galaxies spread across the pages of ASTRONOMY, take note of the various features galaxies show. By doing so you'll see a little bit of the character that makes up these fundamental building blocks of the universe. Though small to the overall fabric of the cosmos, they are immeasurably large to us and offer a great deal of understanding about the place in which we live. □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AQUILA
M 11
SCUTUM
CAPRICORNUS
SAGITTARIUS

# Return of the PERSEID COMET

The parent comet of the Perseid meteor shower is back and putting on a good show on the eve of 1993.

by Richard Talcott

Grab a pair of binoculars, head out to a dark observing site, and gaze upon a famous comet that hasn't been seen in 130 years. It is Swift-Tuttle, named after Horace Tuttle and Lewis Swift, who discovered the comet independently in the 19th century. Swift-Tuttle appears brightest in late November and early December 1992, so hasten.

Swift-Tuttle isn't the brightest comet ever to appear in our sky. At its peak, the comet should barely be visible to the naked-eye, though it will be a fine object in binoculars or a small telescope.

Swift-Tuttle's fame stems not from its brightness, but from its association with the Perseid meteor shower. Each year around August 12, Earthbound observers witness a spectacular display of "shooting stars," or meteors, as tiny dust particles burn up in our atmosphere. These incandescent dust motes are debris left behind by Comet Swift-Tuttle after innumerable trips around the Sun.

Though the Perseids return dependably year after year, its parent comet has been somewhat less faithful. Swift-Tuttle last appeared in our sky in 1862. Astronomers of the day analyzed its orbit and calculated that it would return in 120 years, during the early 1980s. But extensive searching then failed to find it.

Not everyone accepted the 120-year period. In the early 1970s, Harvard-Smithsonian astronomer Brian Marsden dug through historical records and found another comet, which had appeared in 1737, with a similar orbit. But to link the 1737 comet with Comet Swift-Tuttle, he had to invoke large "non-gravitational" forces. In other words, jets of gas shooting from the comet's nucleus had to be altering the orbit of the comet, causing the period to lengthen. If Marsden was right, the comet should return in 1992.

**SWIFT-TUTTLE TRAVERSES** Hercules and Aquila in late November and early December, when you'll get your best views of the comet. Positions are shown for 8 p.m. EST (7 p.m. CST, 6 p.m. MST, and 5 p.m. PST).

That's where the matter stood until the morning of September 27, when Japanese astronomer Tsuruhiko Kiuchi spotted a faint smudge of light in his 25x150 binoculars. Within a day the sighting was confirmed and the link made to Comet Swift-Tuttle — the Perseids' parent comet was back!

In the second half of November, the comet moves through Bootes into Hercules and appears in the evening sky. This is the best time to look for Swift-Tuttle — it is at its brightest (about magnitude 5) and the Moon is out of the evening sky. Look for it slightly south of due west about 30° above the horizon (for an observer at 40° north latitude) as the last vestiges of twilight fade away.

As December begins, the comet moves into Aquila, where it remains until it passes perihelion on December 12. It closes out the year in western Capricornus. During December, Swift-Tuttle sinks toward the west-southwestern horizon with each passing day. At midmonth it lies 15° high and at month's end it is right on the horizon as twilight ends.

Throughout November and December, Swift-Tuttle should shine between magnitude 5 and 6, though predicting the brightness of a comet is at best an inexact science. Expect the comet to appear as a patch of fuzzy light without a tail. It never comes closer than 89 million miles from the Sun, so it doesn't warm up enough to sublimate, or vaporize, enough particles to form a bright tail.

Henry Holt, Greg Leonard, and Brian Cudmik

Jack Newton

**A FAINT FUZZY PATCH** photographed in September, Comet Swift-Tuttle quickly brightened to near naked-eye visibility.

Once January dawns, you can pretty much forget the comet — by then it is low in the southern sky and appears too near the Sun. But astronomers certainly won't forget Swift-Tuttle. Brian Marsden predicts that the comet will reach perihelion next on July 11, 2126, but strong non-gravitational forces make this date uncertain. And he adds, "The uncertainty in the perihelion date covers a dangerous period — if the comet arrives just 15 days later, it could collide with Earth." Though none of us are likely to see this future return, we can all watch its current legacy shooting across the sky on the balmy nights of August. ☐

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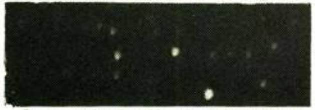

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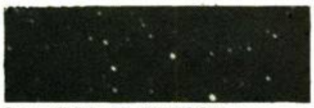

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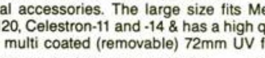
**1.8x Multiplier Lens (2'' Barlow)**

LUMICON 1.8x Multiplier Lens (2" Barlow) **$235.00**

## LARGE UV/DUST SEAL



Protect the optics of your 8-14" Schmidt-Cassegrain with a UV/Dust Seal. Simply thread it onto the rear cell, then attach all normal accessories. The large size fits Meade 2120, Celestron-11 and -14 & has a high quality multi coated (removable) 72mm UV filter.

| | |
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| UV/Dust Seal for Meade 2080, 2045 | **$39.00** |
| UV/Dust Seal (large) for Meade 2120 | **$89.50** |
| UV/Dust Seal for Celestron-11, -14 | **$89.50** |

## NEW! LOW PROFILE HELICAL FOCUSERS

**FROM $59.50**

**LUMICON® LOW PROFILE FOCUSERS**

LUMICON now offers 3 different low-profile helical focusers. They stand only 1¼-1½" above the telescope tube. Use the 1¼" or 2" versions for viewing. Use the 2" non-rotating focuser for convenient photography with the LUMICON 2" EASY-GUIDER™.

**Select your desired base-plate shape!** Flat, 7" OD, 9½" OD, 12½" OD, 16" OD, 21" OD.

| | |
|---|---|
| **LUMICON 1¼'' Helical Focuser** | **$59.50** |
| **LUMICON 2'' Helical Focuser** 1½" high | **$65.00** |
| **LUMICON Non-rotating Helical Focuser** | **$129.00** |
| 2" rack & pinion focuser, only 2" high | **$139.00** |
| 3 handles for non-rotating focuser | **$12.95** |
| **2''/1¼'' adapter** w/48mm filter threads | **$20.00** |
| **2'' LUMICON EASY-GUIDER** | **$169.50** |

## LUMICON 50mm, 80mm SUPER-FINDER™

Visual Astronomers prefer the LUMICON 80mm SUPER-FINDER™, since hundreds of deep-sky objects, including most Messier objects, are visible directly. SUPER-FINDERS also make nice small portable telescopes. 80mm aperture, F=300mm coated achromat or 50mm, F=200mm coated achromat. Eyepieces and/or star diagonal are extra.

| | |
|---|---|
| 1¼" 50mm Finderscope **$59.50**, right-angle | **$59.50** |
| 1¼" straight-thru 80mm SUPER-FINDER | **$169** |
| 1¼" right-angle 80mm SUPER-FINDER | **$179.50** |
| 1¼" right-angle version, w/star diagonal | **$209** |
| 25mm Cross-hair 1¼" eyepiece (12X) | **$39** |
| 1¼" Star Diagonal **$39**, Mounting Brackets, | **$49.50** |
| 1¼" Amici Prism diag. for correct left-right views | **$89.50** |

## LOTS OF ADAPTERS

| | |
|---|---|
| 2" adapter for C-8, Meade 2080, etc. | **$26.00** |
| 2" adapter for C-80, C-100 refractor | **$39.50** |
| 2" adapter for C-70, C-80F, C-100F fluorite | **$39.50** |
| 2" adapter for C-6, Comet Catcher, Meade 312 | **$30.00** |

## EXTENSION TUBES

| | |
|---|---|
| 1" long 1¼" OD thread-in extension | **12.00** |
| 2½" long extension (holds 1¼" filters) | **16.00** |
| 4½" long extension for 1¼" eyepieces | **$25.00** |
| 3" long extension for 2" eyepieces* | **$26.00** |
| 2" long extension for 2" eyepieces* | **$26.00** |

## VIEWING ADAPTERS

| | |
|---|---|
| 2"/1¼" reducing bushing,threaded 48mm* | **$20.00** |
| 2"/T-thread adapter, threaded 48mm* | **$25.00** |
| T-thread/1¼" adapter | **$25.00** |
| F/10 2" or 1¼" eyepiece viewing adapter for Giant Easy-Guider | **$39.50** |
| Low profile star diagonal eyepiece holder | **$16.00** |
| Meade 2" Diagonal/Giant Easy-Guider | **$39.50** |

**Threaded to hold 48mm filters.*

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LUMICON carries a full line of telescopes & accessories. Fast delivery, competitive prices.

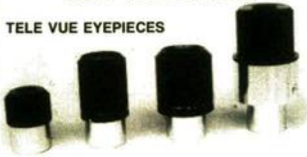
# LUMICON FOR HIGH PERFORMANCE

## ASTROPHOTO OF THE MONTH

**NGC 2264 "The Cone Nebula" in Monoceros.** 70 minute photo by Eraldo Guidolin (in Italy) using an 8" f/10 telescope, a LUMICON Cassegrain Easy-Guider at f/6 and hypered 2415 film with a LUMICON Deep-Sky Filter. Mr. Guidolin stated, " . . . Congratulations for your good service and the high quality of your products. With your guider I have taken hundreds of high quality photographs, perfectly guided."

## TELE VUE™
### *USE THE BEST!*

**TELE VUE EYEPIECES**



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|---|---|
| **Genesis 4" f/5 4 element fluorite** | **$1595** |
| Pronto 70mm f/6.4 apochromat w/2" diagonal | **$698** |
| Pronto 70mm f/6.4 w/Porro prism | **$649** |
| Complete Equatorial Mount | **$795** |
| Motor Drive for above mount | **$198** |
| **7.4, 10.4, 13, 17, 21, 26mm Plossl** 50° | **$89** |
| **1.8x or 2.5x Tele Vue Barlow Lens** | **$89** |
| **2" Giant Barlow - 2x** | **$189** |
| **32mm Plossl**, widest true field in 1¼" | **$109** |
| **55mm 2" Plossl**, widest possible field | **$219** |
| **15mm Wide-Field**, 1¼" eyepiece, 65° | **$135** |
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| **24mm Wide-Field**, "superb," 65° | **$169** |
| **32mm Wide-Field**, 2" eyepiece, 65° | **$239** |
| **40mm Wide-Field**, "awesome," 65° | **$299** |
| **4.8mm Nagler**, 82° field | **$149** |
| **7mm Nagler**, 1¼" eyepiece, 82° field | **$189** |
| **9mm Nagler**, 82° field, "the best" | **$219** |
| **11mm Nagler**, 82° field, 1¼" or 2" | **$235** |
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| **2" Paracorr Visual Coma Corrector** | **$249** |
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| **NEW! 35mm Panoptic 2", 68° field** | **$325** |

## ADJUSTABLE PIGGYBACK MOUNT

The LUMICON adjustable piggyback mount is ideal for telescopes of 6-16" aperture. It permits **both** vertical and sideways adjustment for optical alignment. Also ideal to mount LUMICON 80mm SUPER-FINDER™, large telephoto lenses and small telescopes up to about 5 lbs.

**LUMICON Adjust. Piggyback Mount $59.50**
Specify telescope size: 6", 8", 10", 11", 14", 16"

## H-ALPHA PASS FILTER

Yields spectacular contrast gains in B&W photograph with telephoto lenses. Yields pinpoint star images. Superb with hypered 2415. For color, use the Minus Violet (MV) Filter.

| **Specify Lens Size** | **H-Alpha** | **(MV)** |
|---|---|---|
| 46, 48, 49mm | **$49.00** | **$39.00** |
| 52, 55, 58, 62mm | **$59.00** | **$49.00** |
| 67, 72, 77mm | **$69.00** | **$59.00** |
| 82mm | **$79.00** | **N/A** |

Hypered 2415 film, 36 exp .. **$10.95, $3/$29**

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LUMICON Products catalogue FREE
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## NEW! ENHANCED ALUMINUM DIAGONAL MIRRORS BOOST TELESCOPE PERFORMANCE

**LUMICON 1.3" & 2.1" enhanced aluminum diagonal mirrors & 1¼" star diagonal.**

The new LUMICON diagonal mirrors have a special enhanced aluminum coating with a protective overcoating for long life. Visible reflectivity is 94-96% compared to 86-89% for standard aluminum coated mirrors. The extra 5-10% transmission is like adding up to an inch of aperture! The substrate is fine annealed Pyrex flat to 1/8 wave.

| | | | | | |
|---|---|---|---|---|---|
| 1.32" | **$35.00** | 1.52" | **$39.00** | 1.83" | **$45.00** |
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## ENHANCED ALUMINUM STAR DIAGONAL

90° star diagonals with 96% reflectivity enhanced aluminum mirrors in a CNC machined black anodized aluminum body. Performance far exceeds prism diagonals.

| | |
|---|---|
| 1¼" (1.32" mirror) | **$99.50** |
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## LUMICON FILTERS — BEST IN THE WORLD!

***"The LUMICON OIII proved to be our favorite... It gave the greatest contrast gain."***
***ASTRONOMY February 1991***

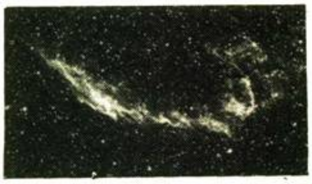
### AMAZING OIII FILTER™

**Helix Nebula, NGC 7293 in Aquarius. Bright and easy with Lumicon Oxygen-III Filter.**

The ultimate in filter performance! The Lumicon Oxygen-III Filter has a contrast twice as high as the high performance Lumicon UHC Filter™. Use the Oxygen-III Filter for observing the very faintest planetary and diffuse emission nebulae. Also gives incredible views of bright nebulae (like M-27, M-17, etc.) from urban locations. Bandpass is 11nm, transmission is 90-96% for both O-III lines at 496nm and 501nm.

### SEE THE HORSEHEAD!

**Horsehead Nebula in Orion.** This faint nebula is seen best with a LUMICON H-Beta Filter. Photo by J. Marling using a Deep-Sky Filter.



**"I CAN SEE THE VEIL NEBULA!"**
Rich Zepernick saw the Veil Nebula for the very first time with a **LUMICON UHC Filter**. He stated, *"It was actually there! and not just around 52 Cygni, but the whole loop! Words cannot possibly express my feelings. I don't know how I managed without these filters."*
**Rich Zepernick, Cresskill, NJ**

### DEEP-SKY FILTER™
### BEST for Astrophotography!

*"Stunning is all I can say,"* says noted astrophotographer Jack Newton. Great for BOTH color and black and white photography.

### BEST WIDE-BAND FILTER!

*"Based on our tests we'd recommend a LUMICON Deep-Sky and Oxygen-III as complementary filters. The LUMICON Deep-Sky Filter clearly had the best contrast for **reflection** nebulae."*
***Astronomy, Feb. 1991***

| | **Premium*** |
|---|---|
| **0.96" LUMICON DEEP-SKY Filter** threads into most 0.96" eyepieces | **$59.50** |
| **1¼" LUMICON DEEP-SKY Filter** threads into most 1¼" eyepieces | **$79.50** |
| **48mm LUMICON DEEP-SKY Filter** (1.7" aperture), threads into most 2" eyepieces. Also fits LUMICON EASY-GUIDERS | **$119.50** |
| **2" LUMICON DEEP-SKY Filter** (1.5" aperture), threads into most 2" eyepieces. Also has male & female camera T-threads for prime focus photography | **$119.50** |
| **72mm LUMICON Giant DEEP-SKY Filter** (62, 67, 77mm adapter, $8) | **$299.50** |
| **2" Rear Cell Filter,** fits SCT's ... Deep-Sky, **$119.50** UHC, O-III, H-Beta, | **$199.50** |
| **1¼" LUMICON UHC Filter** threads into most 1¼" eyepieces | **$99.50** |
| **48mm LUMICON UHC Filter** (1.75" aperture) fits most 2" eyepieces | **$199.50** |
| Set of both premium **DEEP-SKY** and **UHC Filters** (Save 11%) ... 1¼" **$159.50**; 48mm | **$279.50** |
| **LUMICON H-BETA Line Filter** (9mm bandpass at 486nm). For the California Nebula, Horsehead Nebula, and other extremely faint nebulae. **1¼"** ... **$99.50, 48mm** | **$199.50** |
| **Oxygen-III Filter** for very faint planetary and diffuse nebulae, 11nm bandpass at 496nm and 501nm O-III lines ... **1¼" $99.50, 48mm** | **$199.50** |
| Telephoto lens adapter for 2" or 48mm filter. Select 46, 49, 52, 55, 58mm | **$6.95** |
| Universal adapter for 1¼" filters. Adapts the 1¼" filters to any 1¼" eyepiece | **$16.00** |
| Universal adapter for 48mm or 2" filters. Allows use of any 1¼" eyepiece | **$20.00** |

**Premium filters are currently the best in the world. All Lumicon filters include individually measured transmission data.*

# DEEP-SKY ASTROPHOTOGRAPHY

# SR-V 3200 NEW FILM

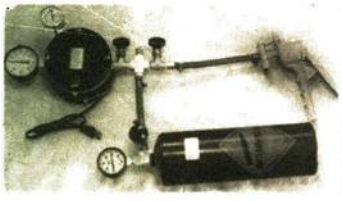
## FILM HYPERSENSITIZATION KITS†

**LUMICON HYPER-KITS™** yield 3-15x film speed gain in long exposures. They are safe & simple to use. Easy HYPER-KIT includes a chamber with all controls and fittings, thermometer, a refillable cylinder of non-flammable forming gas & hand-operated vacuum pump.

U.S. Patent 4,473,636

## MAKE YOUR OWN HYPERED FILM

**MODEL 300 HYPER-KIT** sensitizes any 35mm film in hours. Best for 2415. Achieves highest possible film speeds ..... **$325**



**MODEL 600 HYPER-KIT** (See photo) Like the Model 300, but also sensitizes 120/220 larger format film and small glass plates ..... **$395**

**MODEL 1200 HYPER-KIT** is for 4X5" plates and film up to 5X7". Has 2 gas cylinders and includes temperature controller ... **$595**

Temperature controller for any HYPER-KIT ..... **$65**

Electric Vacuum Pump, Model R-10 **$325**

## GUIDE OFF-AXIS FOR LOVELY ASTROPHOTOS

All **LUMICON EASY-GUIDER™** off-axis guiders† have both radial and 360° rotational adjustments for 5X easier guide-star selection, use 48mm filters, 360° camera rotation, large prisms for bright guide-stars.
*Specify Camera and Telescope type.*
*U.S. Patent 4,448,500*

### NEWTONIAN EASY-GUIDER™

Full aperture. Installs in seconds. Specify 2" or 1¼".

| | |
|---|---|
| NEWTONIAN EASY-GUIDER | **$169.50** |
| 3X Relay Diagonal (see photo) | **$89.50** |
| Illuminated reticle eyepiece system | **$99.50** |

Guider for Hasselblad **$350**, Mamiya 645 **$199**
Pentax 6X7 **add $119;** Pentax 645 **add $139**

### CASSEGRAIN EASY-GUIDER™

For C-8, Meade 2080, Cynamax-8. Includes 50mm achromatic lens for f/5.8 operation—3X shorter exposures! **Superb rich field viewing, too!**

CASSEGRAIN EASY-GUIDER ..... **$225.00**
Adapter for Hasselblad **$198,** Mamiya 645 **$98**
Pentax 6X7 **add $119;** Pentax 645 **add $139**

### GIANT EASY-GUIDER™

For Celestron-11, C-14, and the 10" Meade 2120. Includes 80mm clear aperture achromatic lens for edge-to-edge illumination & pin-point star images. F-ratio adjustable f/4-f/11. **Also yields unmatched Rich-Field viewing.**

GIANT EASY-GUIDER ..... **$395.00**
48mm DEEP-SKY Filter ordered with any EASY-GUIDER (SAVE $20) ..... **add $99.95**
Adapter for Hasselblad **$229,** Mamiya 645**$129**
Pentax 6X7 **add $129;** Pentax 645 **add $149**

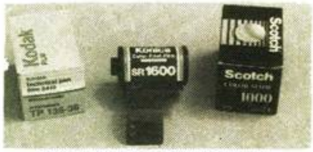
## WHAT DO YOU NEED?

1. Illuminated reticle eyepiece ...... **$99.50**
Lumicon 12mm eyepiece system has adjustable LED illumination, dual crosslines, battery pack.

2. Cable release for long exposures .. **$9.95**

3. **LUMICON Quartz Drive Corrector . $219**
Dual-axis drive corrector is essential for astrophotography and/or field use of your telescope. 40Hz/80Hz variable output controls telescope drive. 60Hz Quartz reference ±12VDC Declination control output. Both 110VAC and 12VDC input for home or field use. Declination reverse switch for Newtonians.

**Declination motor (state telescope) .. $99**
**NEW** Deluxe Digital Qtz. Drive Correc. **$298**



## HYPERSENSITIZED FILM

LUMICON Hypersensitized film is essential for good deep-sky astrophotography. Deduct 10% for 3 or more rolls (mixed o.k.).***No C.O.D.s.***

| **Film Type, 35mm** | **Exposures** | **Price** |
|---|---|---|
| 2415, Ultra-fine B&W, red sens. | 36 | **$10.95** |
| SR-G3200, fastest of all, color neg | 24 | **$13.95** |
| Kodak Ektar 1000 fast, fine grain | 24 | **$12.95** |
| Fuji HG400 fine grain color neg. | 12 | **$10.95** |
| 3M 1000, fastest slide film | 12 | **$12.95** |
| Fujichrome RD100, fine grain slide | 24 | **$12.95** |
| D-19 B&W Developer | 1 gal. | **$6.95** |

# Night visions

## Expert astrophotographers confess what inspires them to photograph the night sky and explain how they got started.

by Alan Dyer

"It's a nutty hobby." You'll hear it from every astrophotographer. You set up elaborate equipment in the dark, aim it at objects you can barely see, open the shutter for exposure times unheard of in any other field of photography, then spend the next hour staring at a single guide star. You jockey the star back and forth attempting to keep it dead center in the eyepiece in what seems like a boring video game.

It's crazy. Even other amateur astronomers can't fathom the fascination astrophotographers have with their craft. It's a fascination that starts with their first astrophoto.

Bill Hood recalls his first photo of the night sky. Hood is one of Southern California's leading astrophotographers who now doesn't think twice about tackling a 90-minute exposure of a nebula or galaxy. "My first astrophoto was a 9-minute exposure of the Lagoon Nebula in Sagittarius. It was only 15° above the horizon — I didn't realize that wasn't a good time to shoot it, but I did anyway on Konica 3200 film. I left that roll in the camera for a month and forgot that I had taken the shot. Then when I had the roll developed and got the prints back I thought 'Wow, look at all that red!' It knocked my socks off."

It's a feeling every astrophotographer shares. Whether it's your first photo or a shot representing the culmination of years of experience, the sight of stars and nebulosity that were invisible to the eye appearing like magic on your photo is a thrill that never fades.

"Film can show you things the human eye alone can't," explains Larry Landolfi. Landolfi's home base is Long Island, New York. Shunning complex equipment, telescopes, and the rigors of hour-long guided exposures, Landolfi specializes in short-exposure portraits of the sky that often include foreground landscapes. But Landolfi shares the deep-sky photographer's sentiments. "To this day it still amazes me that I can put my 35mm camera on a tripod, with fast film, and do a 25-second exposure of Orion and there's the Orion Nebula. The biggest thrill of astrophotography is recording stars that you can't see with the unaided eye, especially with all their colors."

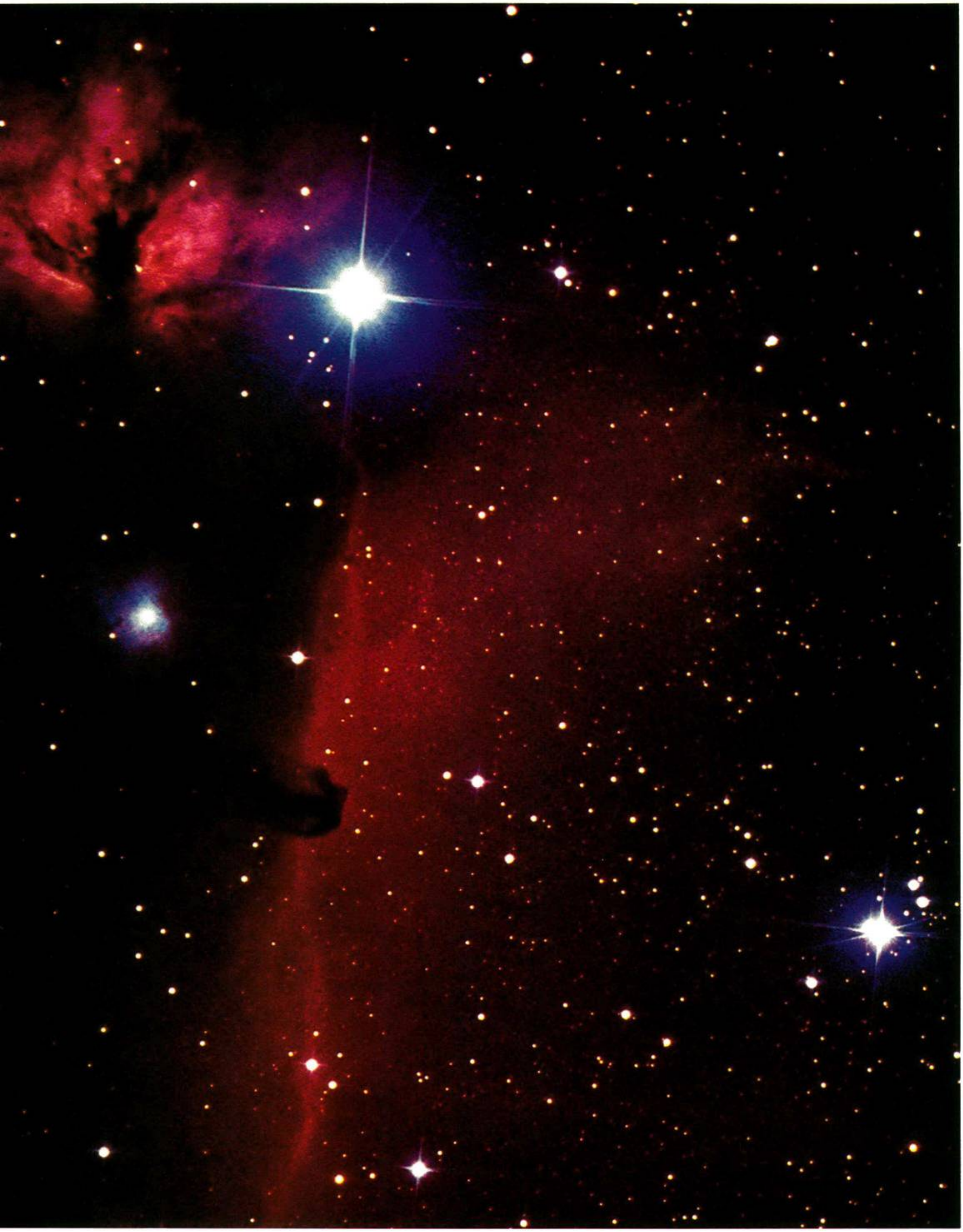
But for every moment of joy in this hobby there are a few moments of disappointment. Hood found that out with his very first astrophoto. "A month later I proudly showed my Lagoon Nebula picture to someone at the local telescope store and they pointed to it and proclaimed 'Yes, but look at the trailed stars!' I didn't even know that was a problem! It burst my bubble but I was hooked."

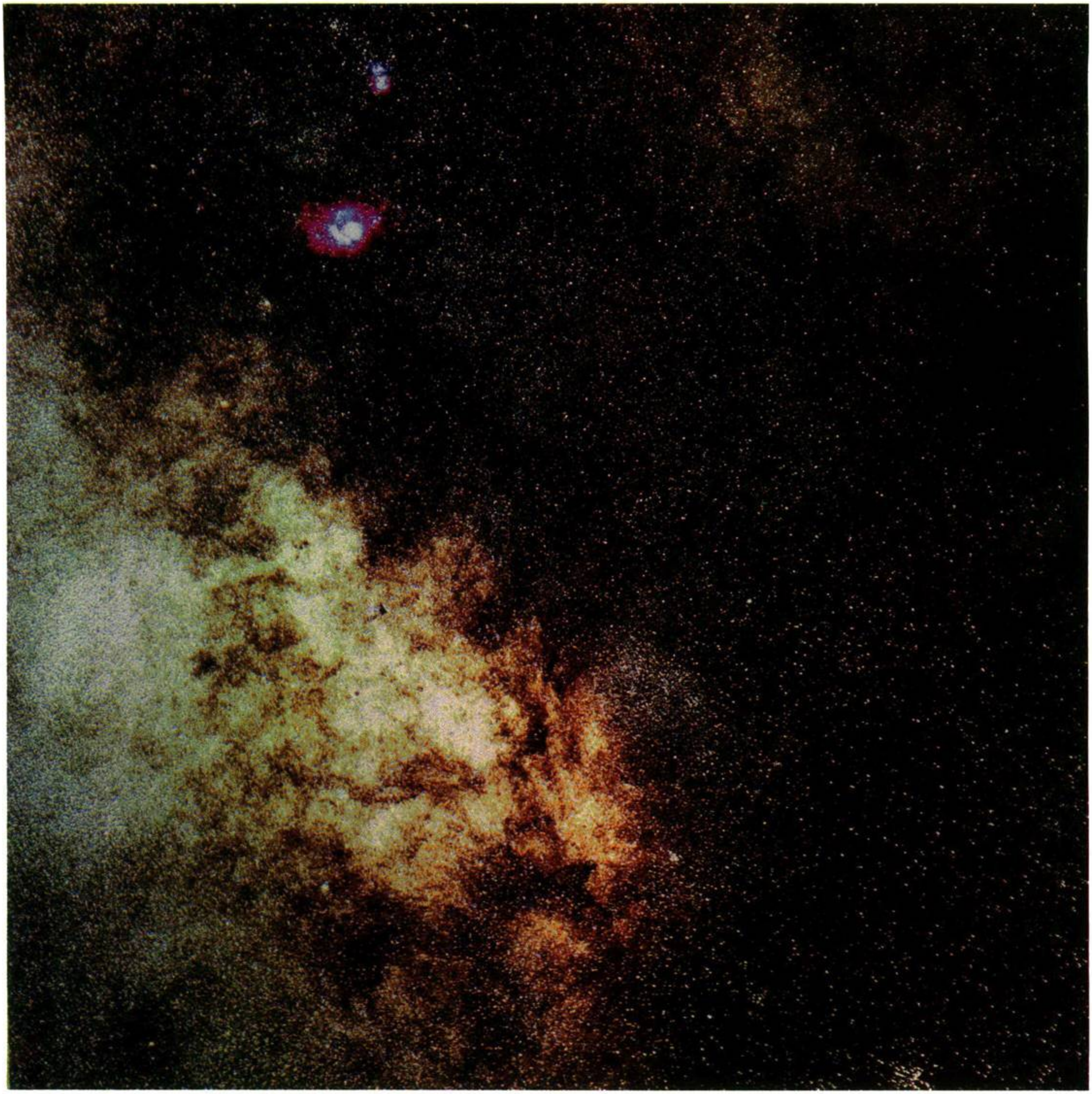
**I got my prints and I thought "Wow, look at all that red!" It knocked my socks off.**

The desire to constantly improve photos is part of what drives astrophotographers. It's a common trait — no one is ever satisfied with the results. No matter how great the picture looks to others, the astrophotographer always knows it could have been better. As Landolfi puts it, "I'm always thinking 'It's got to be better, it's got to be sharper, it's got to be more saturated.'"

For sharpness and color saturation, the photos of Ronald Royer stand out. Over the years Royer has perfected

**Horsehead Nebula by Bill and Sally Fletcher**





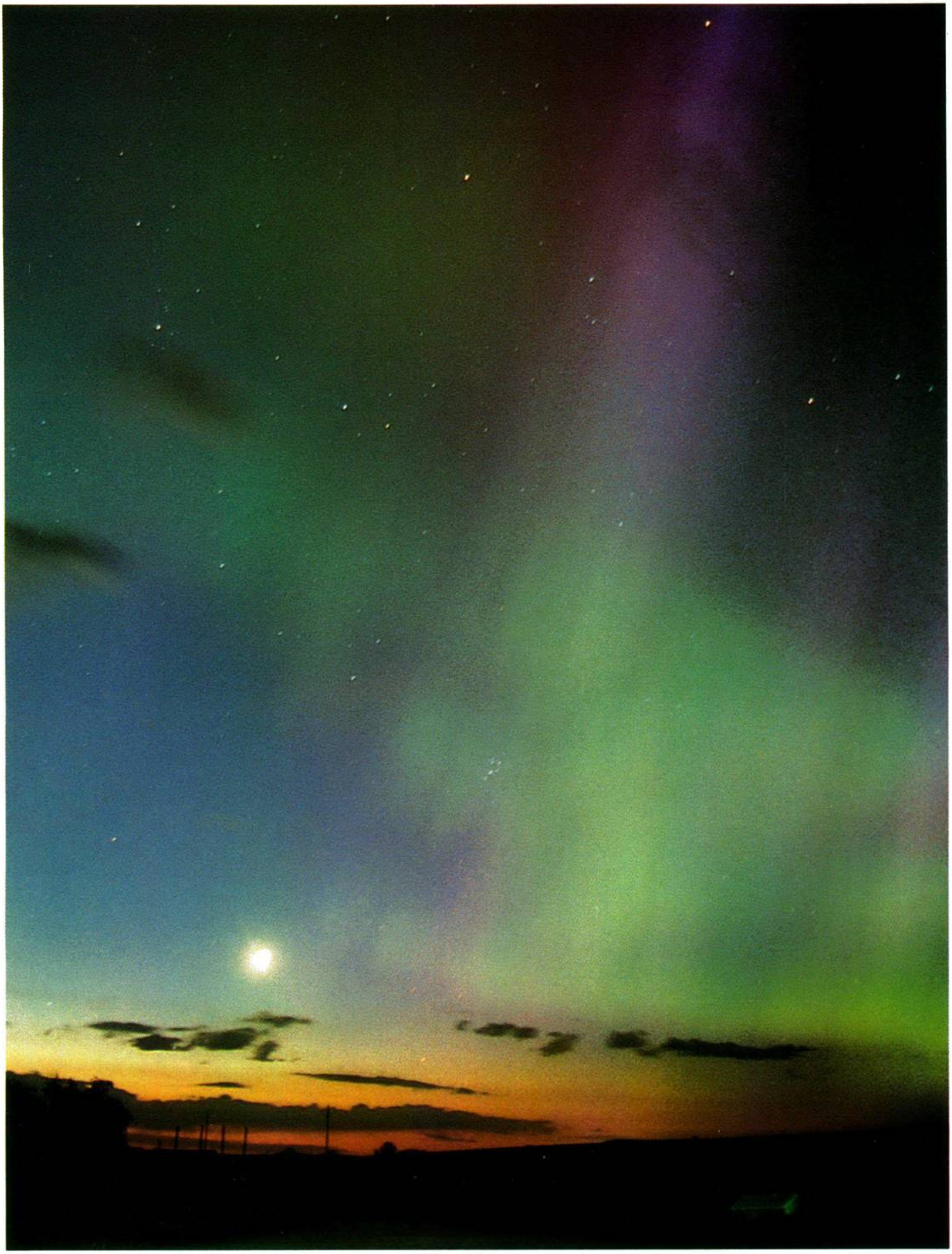
Sagittarius starcloud by Ronald Royer and Steve Padilla

Aurora by Jay Brausch (right)

**A photograph gives you something you can share with other people.**

techniques such as creating color images by combining three black-and-white originals. Most amateurs would love to call his photos their own. But even Royer works toward better images. "The great thing about this hobby is that it involves many disciplines — optics, photography, mechanics, and now electronics and computers. It's always a challenge — you never feel you've got it down cold. There's always an improvement to be made."

Royer also points out something astrophotographers rarely like to admit. They take pictures because they enjoy showing them to other people. "You go out to a telescope," says Royer, "and once you take your eye away from the eyepiece all you can do is talk about what you saw. But a photograph gives you something tangible you can share with other people." Whether it's at the local astronomy club, through publishing in magazines or even, as Royer has often done, by getting astrophotos on the local TV news, sharing your photos is a big part of the satisfaction. It's how you get the payoff for the time spent at the telescope or in the



darkroom. "There's a big market for amateur astrophotographs of all types," explains Royer, "because amateurs often can do better than professionals."

Contrary to what many people starting out in backyard astronomy might think, professional astronomers with the big telescopes often don't get the best astrophotos. As Royer relates, "When Comet West was around in 1976 the Palomar Schmidt Camera was clouded out but amateurs were able to travel into the desert. We were more flexible. An amateur who has a clear sky is better off than a professional astronomer under clouds, especially for anything transient in the sky — a comet, an eclipse, a planetary conjunction, or a sudden meteor shower."

Then there's the fact that most professional observatories simply don't do photography any more. If professional astronomers take images at all, they're digital images obtained with electronic CCD cameras. The results are great for research but often lack the impact of a wide-field color image taken on film. It's now fallen to the amateur to get beautiful color images of the night sky and of special events such as eclipses. When magazine and book publishers, as well as businesses such as advertising agencies, want striking astronomical images, they now turn to the increasing legion of amateur astrophotographers. Some amateurs are even finding they can make money selling their pictures.

Bill Hood would agree with Royer, however, that the real satisfaction comes from showing photos firsthand to people. Hood enjoys exhibiting his astronomical portraits in art shows at local galleries. "I love to talk to people at these shows. The people who see my photos are like me a few years ago — they have an interest but they know nothing about the sky. When I see them at another show they tell me, 'I went out and bought a pair of binoculars like you suggested and I can't believe what I've been able to see.'"

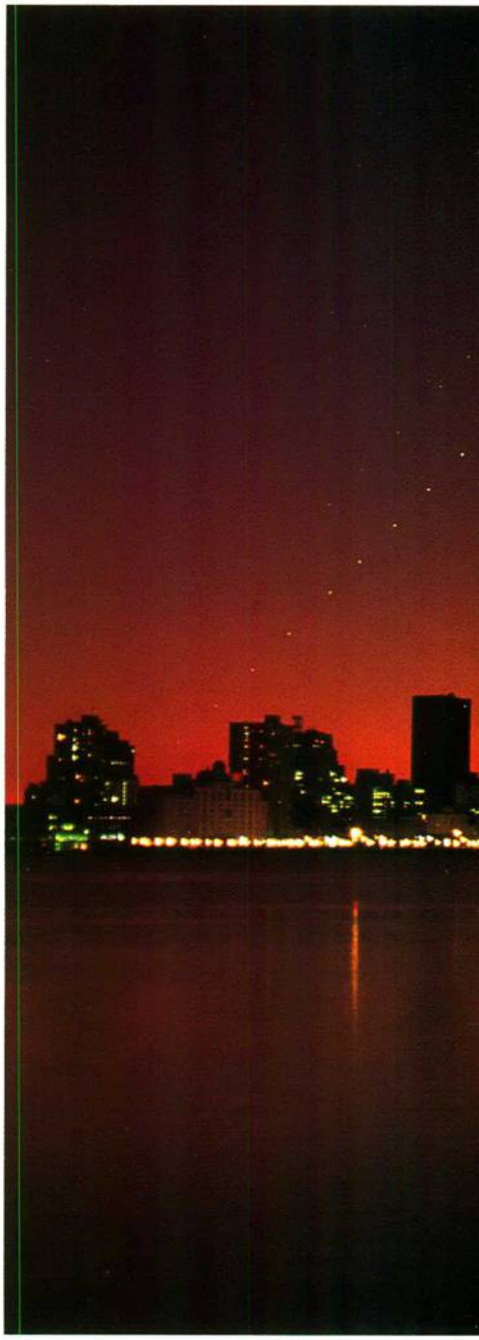
Talking to others about your photography is not only enjoyable, it can also prove instructional. Sally and Bill Fletcher are part of the Southern California contingent of astrophotographers who meet on Mt. Pinos every dark-of-the-Moon weekend to do their photography together. "We are fortunate," comments Sally, "because we can go up to Mt. Pinos where there are a half dozen other astrophotographers who are as nutty as we are who we can talk to and share our experiences with. We look forward to seeing them each month." The fusion of ideas and techniques that has emerged from the Mt. Pinos group over the last few years has resulted in some of the finest astrophotos ever produced by amateur astronomers. "We're kind of a rat pack up there," jokes Bill.

As it has for so many other astrophotographers around the world, the rat pack's work has inspired Bill and Sally to strive for ever higher standards of sharpness and color saturation. "We admire the work of our astro-buddies — Kim Zussman, Tony Hallas, Michael Stecker. But in the beginning the guy who made me the most jealous was David Malin. We had a love-hate relationship with his photos."

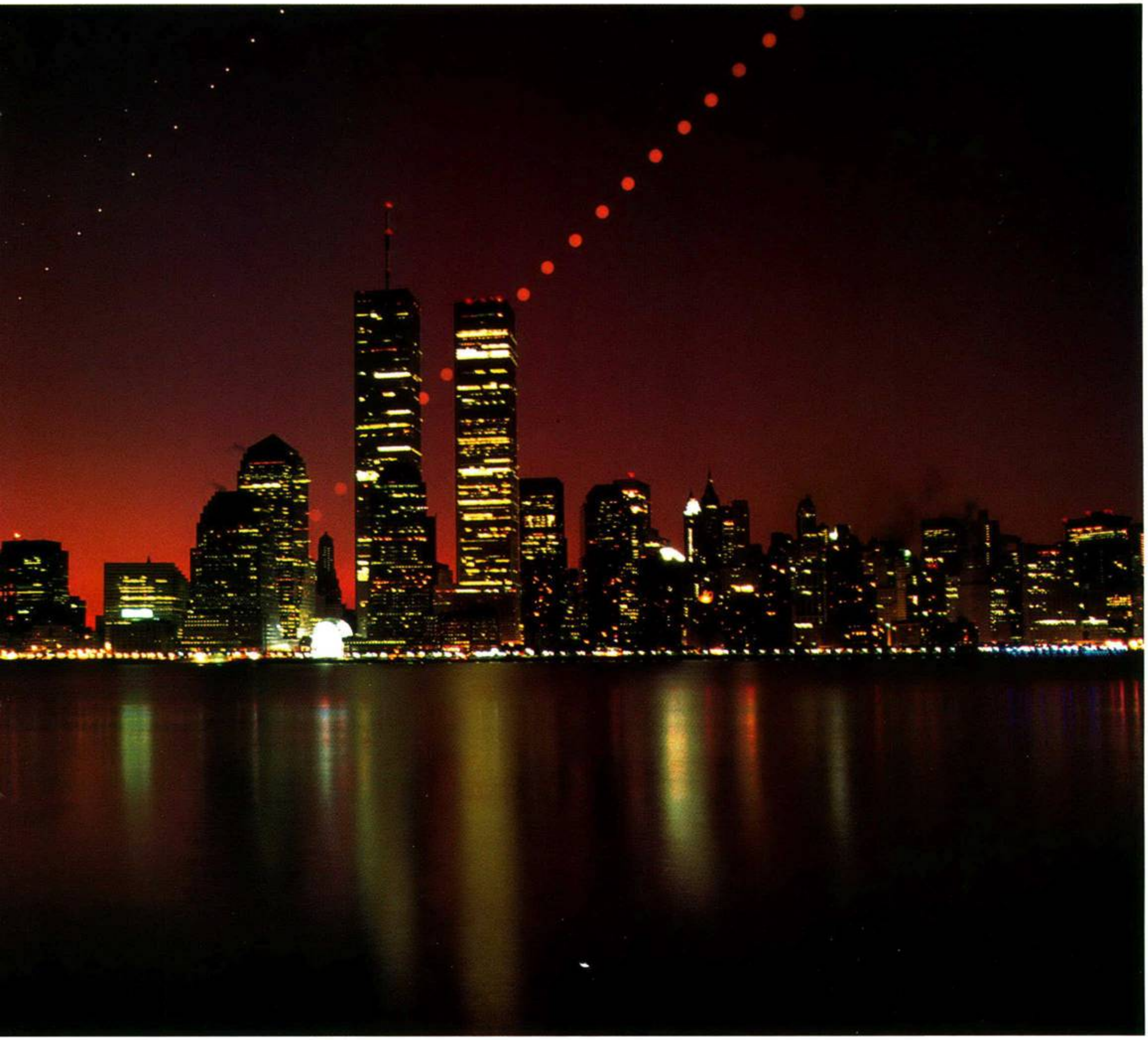
**You see the magazine pictures long enough and you wish you could take one of those.**

Most astrophotographers would agree. Malin's deep-sky photos taken with the Anglo-Australian Telescope and other large observatory instruments are known the world over for their unprecedented clarity and vivid colors. Seeing images such as Malin's and the Fletchers' is one of the great inspirations in this hobby. Landolfi agrees. "I love all the astrophotos I see in the magazines. I'm a great fan of people like Tony Hallas and Daphne Mount, Akira Fuji, and Dennis Di-Cicco. You see their magazine pictures often enough and you just wish you could take one of those."

As impressive as the deep-sky photos are from people such as Ron Royer, Bill Hood, and the Fletchers, hour-long exposures through telescopes aren't the only way to create beautiful night-sky images. Jerry Schad became interested in astronomy at age 12 back in 1962. "In the 1960s," remembers Schad, "astrophotography was really a passion for me. I had to take photographs of every deep-sky object. I was using an Optical Craftsmen reflector and black-and-white 103a films.



"Then in the late 60s and early 70s I became interested in the outdoors. I started writing guidebooks on hiking and bicycle touring. My interest in the outdoors shifted my interest in astrophotography from mug shots of objects to color portraits of the skies with some sort of natural foreground. This type of astrophotography was different from what most other people were doing. And also much simpler." In fact, Schad takes many of his astrophotos with no more than a cam-



**Rising Sun and planets by Larry Landolfi**

era on a tripod, although he adds, "I sometimes use a little tracker that I bought at the time Comet Halley was around. It's a low-tech hand-cranked platform that allows me to take longer exposures and stop the stars from trailing."

Schad's work is also unorthodox in that he often takes starfield photos when the Moon is in the sky. The moonlight illuminates the landscape, an important part of the image for Schad. "I love to get to scenic locations such as the Grand Canyon, Utah's canyonlands, Devil's Tower, and Mount Rainier National Park. The events I watch for are conjunctions, eclipses, young thin crescent moons, and the rising Full Moon. I find it challenging to predict how an event or alignment in the sky will look behind some interesting foreground, then I go out and get that shot. That's my game."

But you needn't go to remote dark-sky sites for great photos. Landolfi's stunning cityscapes prove that. "From where I live on Long Island I'm landlocked! I can't take great close-ups of nebulae. Instead I concentrate on the specialty that I really love — time-lapse shots of the sky moving. I sometimes get up at 2 or 3 a.m. to drive into the city to get to a good location for a shot. I don't normally have a lot of patience but I have no problem with standing outside in the cold for 4 or 5 hours to take one multiple-exposure picture of the Moon or Sun rising. I'd rather take one picture that makes people go 'Ooh!' than take a bunch of snapshots."

Not all astrophotographers take pictures simply for their pictorial value. For some their photos are part

Summer Milky Way by Jerry Schad

## ABOUT THE PHOTOS

**Pages 70-71:** Horsehead Nebula by Bill and Sally Fletcher, 8-inch f/4.5 reflector, 70 minutes, unhypered Fuji Super HG400.

**Page 72:** Sagittarius starcloud by Ronald Royer and Steve Padilla, 4-inch f/5 wide-field astrographic lens, color image created from three 4x5 black-and-white negatives shot through red, green, and blue filters.

**Page 73:** Purple aurora amid twilight and moonlight by Jay Brausch, July 9, 1991, Glen Ullin, North Dakota.

**Page 74-75:** Jupiter, Venus, and the Sun rising over Manhattan by Larry Landolfi, October 9, 1991, 28mm lens, Fuji Velvia film.

**Page 76:** Milky Way over pine forest by Jerry Schad, 24mm lens at f/1.4, 2-minute tracked exposure, Ektachrome P800/1600 pushed to ISO 1600.

**Page 77:** The Trifid Nebula in Sagittarius by Bill Hood, 8-inch Schmidt-Cassegrain at f/10, 45 minutes, hypered Fuji Super HG400.

of a program of observations. Ron Royer, for example, takes pictures of the fields around variable stars that are then used to produce detailed finder charts for the American Association of Variable Star Observers.

For Jay Brausch, astrophotos are an important part of a personal decade-long program of Sun and aurora watching. "I live at the edge of a small town in western North Dakota," explains Brausch. "I can just walk out and see aurorae. So in the early 1980s I started to write down on what nights I saw aurorae. I've got the environment out here in the country that allows me to do this kind of observation. It's a sky no one can take away from me. It's always there."

Brausch has taken advantage of his location to produce some astonishing auroral portraits. But they certainly aren't accidental creations. "I use a 35mm camera with a 28mm and 50mm lens, plus a 60mm refractor telescope for observing the Sun. I watch for sunspots as they come round the edge of the Sun — they alert me to the possibility of a bright aurora in a few days. I'm out checking for aurorae every night. I go out one to three times per hour if there's not much activity. If there's lots of activity then, I'll be out there with the camera, photographing and timing the surges. As of late 1992, I've logged about 6,000 hours of aurora watching and have observed over 1,000 aurorae. My ultimate goal is to work as an observer for an organization such as NOAA or the National Weather Service."

But even someone as dedicated and as well-prepared as Brausch occasionally misses a chance for a great photo. "Sometimes I fail to get aurorae at their best because I don't have the camera ready or I have the wrong lens on it. By the time I get everything set up the aurora has died down." Brausch's advice for aurora photographers: "Be under a black sky and always have the equipment ready to go."

Being in the right place at the right time with the right equipment is one way to get great astrophotos. Most astrophotographers also echo the advice that Sally Fletcher provides: "I think it's important to learn the sky first. Learn what's out there and where things are." Bill Fletcher adds, "There are always disappointments when photos don't turn out. But when you get one bad picture it helps you

Trifid Nebula by Bill Hood

**I'd rather take one picture that makes people go "Ooh!" than take a bunch of snapshots.**

make the next one better and that's a process that never ends." To help you get started, Royer suggests, "Start out reading all you can — books and magazines. Read the photographic data carefully. It can save you a lot of trial and error." Then as Landolfi recommends, "Just go out and shoot and you'll get better at it."

So why do astrophotography? The Fletchers put it this way — "Doing astrophotography is like riding around the universe with a camera, looking out to the full canopy of stars. We can take pictures of them as we go by. It just gets in your blood. You can't wait to get back out there again, no matter what happens the first time.

"To answer those people who say, 'Why bother spending all that time taking pictures?' — well, it's hard to come up with an answer. It's a mystery to us too!"

"I know it's sometimes hard to come up with an original picture," says Landolfi. "The Orion Nebula has been photographed countless times. So why do I do it? You know, I can't even give you a good bluff answer. You just love it. You're born to it. It's great to take a picture of something your eye cannot see. It still amazes me even if I take a picture of the same thing a hundred times." ☐

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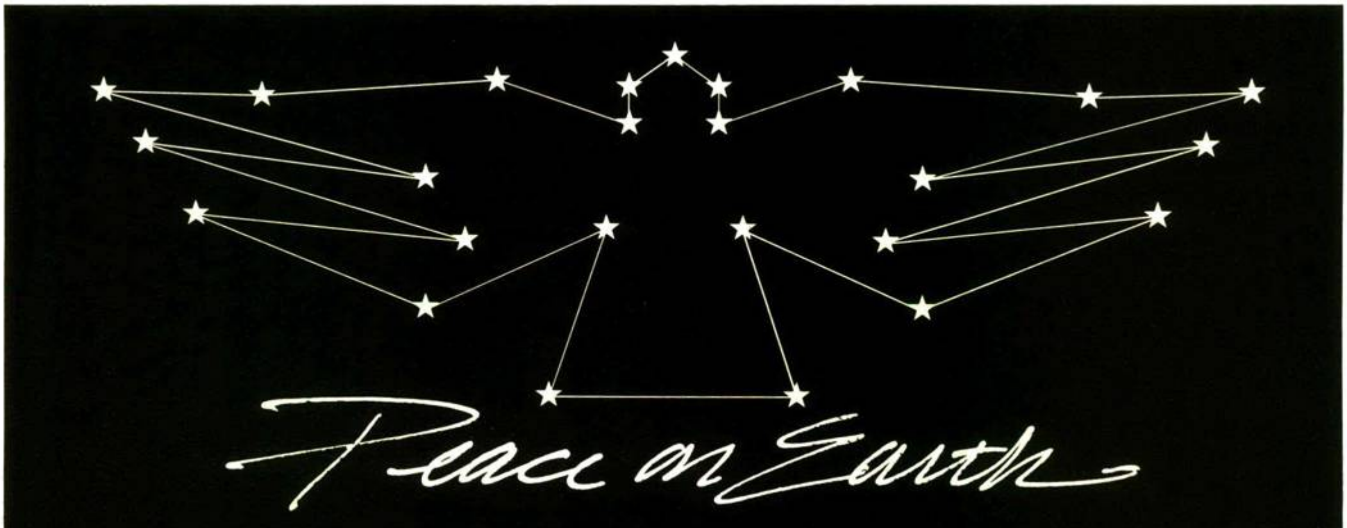

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| Ultima | 7x50 | 7.0° | 20mm | 27 oz. |
| Ultima | 10x50 | 5.0° | 21mm | 27 oz. |
| Ultima | 8x56 | 6.1° | 21mm | 31 oz. |
| ED | 6.5x44 | 7.3° | 20mm | 26 oz. |
| ED | 9.5x44 | 6.0° | 18mm | 26 oz. |
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# YOUR FIRST DATE WITH A 2.4-INCH SCOPE

ASTRONOMY: All equipment photos by Darla Gawelski

## Use these tips to set up your first scope and start observing planets and deep-sky objects.

by Greg Beabout

You just bought a 2.4-inch refractor or received the scope as a gift. Or maybe you bought your child his or her first telescope. Now what? Your first questions are probably "How do I set it up?" and "What can I see with my new telescope?"

Assembling the box full of strange-looking parts into a working telescope can seem a little daunting, especially if the instructions that came with the scope are poorly written. The good news is that it looks harder than it really is and you have to do it *only once*. When you have the scope assembled, you'll be ready to observe the many objects visible in small scopes — lunar craters, Saturn's rings, Jupiter's moons, the phases of Venus, double stars, and deep-sky objects such as the Orion Nebula.

### Setting Up Your Scope

Three major steps convert the collection of parts into a telescope: assembling the tripod and mount, attaching the telescope tube to the mount, and attaching the finderscope to the tube. To get started, determine whether your scope has an altazimuth or equatorial mount. Both types of mount allow you to find objects and track them as they move through the sky by moving the scope about two axes. The altazimuth mount, like a camera tripod, allows you to move the scope both up and down and around your horizon. An equatorial mount has its polar axis aligned with Earth's rotational axis to permit a single movement of the scope to track an object.

The box should indicate which mount you have; if not, use the pictures on pages 82 and 83 to determine the type of mount. As you assemble your scope, refer to the pictures on page 82 for an altazimuth mount and those on page 83 for an equatorially mounted scope to see how the parts fit together. The diagrams on page 84 will help you learn the names of the different parts.

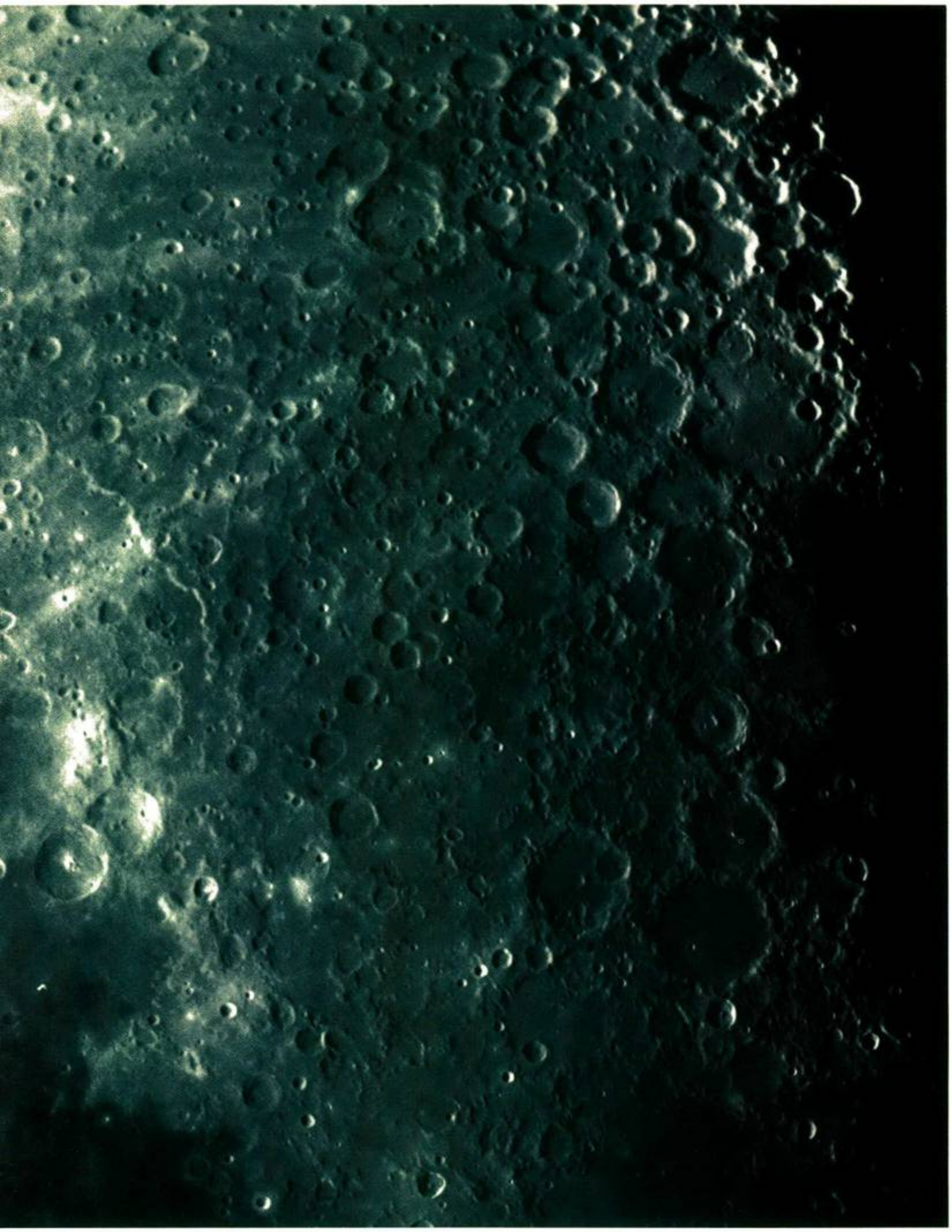
For both types of mounts, start assembly by attaching the legs to the mount. Each leg joins the mount with a bolt that either passes through the leg and mount or slides into a slot. Next attach the tripod tray. The tray is a convenient place to put your eyepieces and it stiffens the tripod to prevent shaking of the image when you look through the scope.

For an equatorial scope, adjust the mount to the proper latitude. You can find your latitude in many road atlases. Turn the mount so the right-ascension gear assembly is at bottom. If you turn it the other way, the gear will interfere with the scope's movement. Screw the counterweight rod into the end of the declination axis. Place the weight about halfway along its rod so it will roughly balance the scope's weight when it's in place.

Attach the slow-motion cables to the mount and you are ready to install the scope. For an equatorial mount, about two-thirds of the front end of the tube should extend beyond the cradle. You can improve the balance by unlocking the declination and right-ascension axis locks, watching which way the scope turns, and moving the scope or counterweight accordingly.

Attach the finder mount to the tube and slide the finderscope into the rings. This small telescope has a large field of view, like that of binoculars, to help you locate objects in the sky and position them so you can see them in the main telescope. At this point, roughly center the finderscope in the rings. Fine adjustment of the finder screws will come later.

Once your scope is assembled, you'll probably not want to take it



Lee C. Coombs

**SMALL SCOPES** give beautiful views of the Moon, like this shot of the region around the crater Ptolemaeus. Observe near the sunlit edge of the Moon for the best sights of craters and mountains.

apart. For ease of transport or storage, you can remove the scope from the mount and collapse the tripod. When you're not using the scope, cover the objective lens, the finderscope lenses, and the hole in the focuser to prevent dust from falling on the optics. If lens caps weren't provided with your scope, use plastic bags and rubber bands to cover the optics.

Now to start using your scope.

### First Practice During the Daytime

If your telescope came with more than one eyepiece, begin with the one that magnifies the least. It shows the largest area of sky, which makes it easier to find objects. Your eyepieces may have numbers on them, such as 20mm. This number is the eyepiece's focal length: the longer the focal length, the lower the magnification and the larger field of sky it shows. If the focal length isn't marked, you can still identify your lowest-magnification eyepiece. The lower the magnification, the larger the lens will be in the eyepiece. If you want to know the power of the eyepiece-scope combination, divide the focal length of the scope — usually printed on the scope's tube near the focuser — by the focal length of the eyepiece.

Normally a scope's image is upside down and mirrored left for right. So before you place the eyepiece in the focuser, you may want to insert the star diagonal to invert the scope's image. It contains a mirror or prism that turns the image right side up, though still mirrored left for right. The view through the diagonal is convenient for viewing terrestrial objects and it prevents strain on your neck when viewing objects high overhead.

Practice using your scope during the daytime both with and without the star diagonal. Insert the low-power eyepiece and focus on a distant object. If you switch from straight-through viewing to using the star diagonal, you need to refocus. Note that if you look at a nearby object such as a tree, then the Moon and stars will be out of focus.

To adjust the finderscope, first find a distant object in the main scope. The object should be as far away as possible, at least a half mile distant. Now use the screws to move the finderscope until the object is centered in the eyepiece or centered on the cross-hair if there is one. Double-check that the object is centered in the main scope and in the finderscope. Now you're ready to look at your first astronomical object.

### Your First Observing Session

You need to take your scope outside for nighttime observing. Looking

through a window results in dim and distorted views. Pick a site that is away from bright lights. Use a house or garage to shield the scope from lights. It may help to cup one hand around your face to block stray light while you look through the telescope.

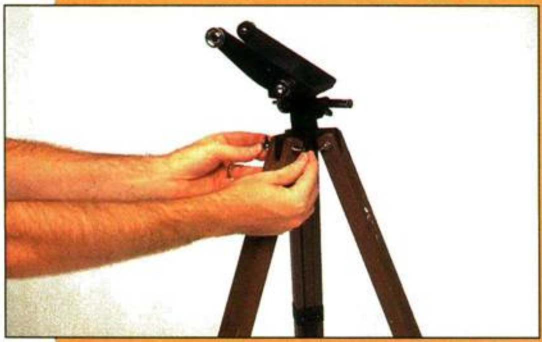
If you have an equatorial mount, orient the mount so the right-ascension axis, also called the polar axis, points to the celestial pole. Stars appear to rotate about this point in the sky. Aligning your scope with the pole permits you to follow an object's motion through the sky by turning only the right-ascension axis of the mount. For Northern Hemisphere observers, the celestial pole lies near Polaris in the Little Dipper. Aligning your scope with Polaris is sufficient. For more detailed polar alignment techniques, see "How to Polar Align Your Telescope" in the May 1992 issue.

The best object to view first with either scope is the Moon because it's easy to find and it presents spectacular views. Start on a clear night when the Moon appears in the evening sky. Because the image in the eyepiece is inverted, it is a bit tricky to aim your scope and it's easy to move it in the wrong direction. After centering the Moon in the finderscope, it isn't hard to center the Moon in the telescope. If the Moon isn't already in the field, you usually can see a bright flare to one side of the eyepiece. Keep moving the scope in that direction to center the Moon. It will take some patience at first to learn how to aim the scope.

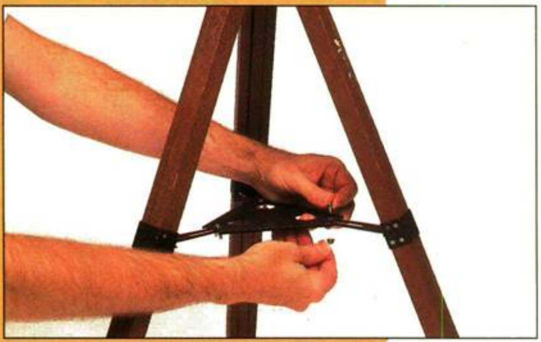
At low magnification, the entire Moon fits within the field of view. Once you have the Moon centered in the eyepiece and in focus, avoid touching the telescope. Every time you nudge the telescope or the tripod, the image through the eyepiece will bounce. Let the image settle until it is still. Atmospheric turbulence also makes the image "boil," but when the telescope and air are both still, usually for only brief moments at a time, you will be amazed by the view and astounded by how clearly craters and mountains appear.

After a short time, you will find that the Moon has moved out of the field of view. Actually the Moon didn't move; rather Earth's ro-

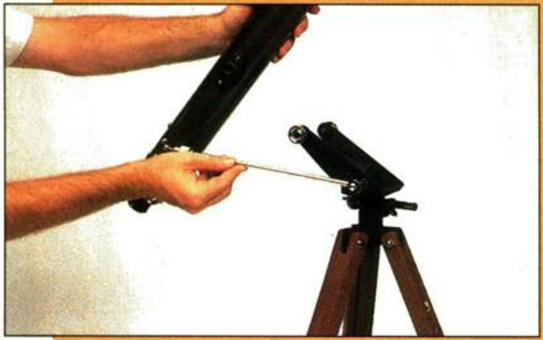
## ASSEMBLING AN ALTAZIMUTH SCOPE



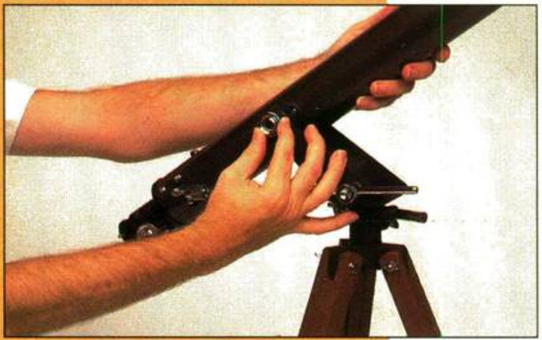
**TRIPOD LEGS** attach to the mount with a bolt and a wing nut. Tight leg bolts keep the scope from shaking.



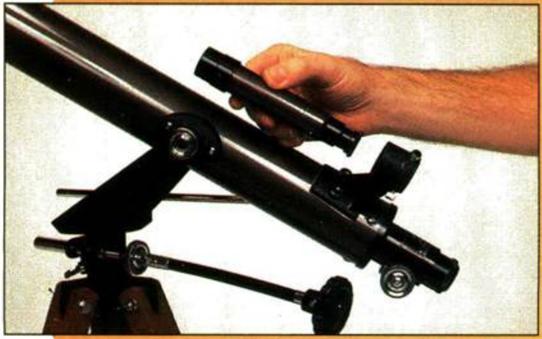
**THE CENTER TRAY** stiffens the tripod to reduce shaking and provides a storage place for eyepieces.



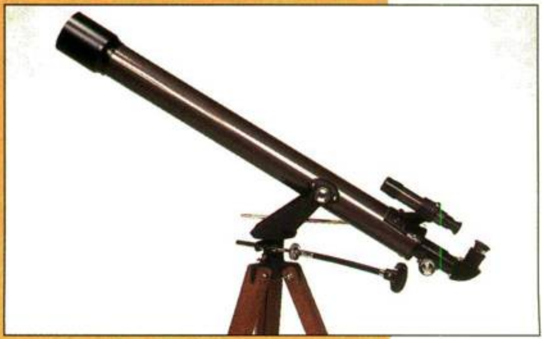
**THE ALTITUDE ROD** fits into the axis lock. The mount points toward the eyepiece end of the scope.



**THE ALTITUDE AXIS SCREWS** press lightly against the metal plates on the tube assembly.



**THE FINDER RING** mounts onto the tube with two screws. Three screws align the finder with the telescope.



**AN EYEPIECE AND STAR DIAGONAL** make this scope ready for observing. Cover the optics when not in use.

tation made the Moon drift out of the field of view. You will have to move the telescope once every minute or so to follow the Moon. At higher magnification, you have to adjust the scope more often to keep the Moon in the smaller field of view.

If you can't see the Moon, you may not have your eye lined up properly with the eyepiece. If you wear eyeglasses, take them off. The focus on the telescope will compensate for near- and farsightedness, though not for astigmatism. Your eye needs to be about one-half inch from the lens, slightly less for high-power eyepieces.

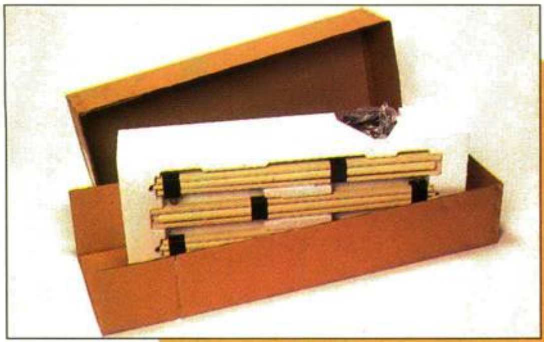
Once you've viewed the Moon, make a note of where the focus is. This will help you put it very nearly back in focus the next time you view the Moon or other night-sky objects. Once you've focused the scope, you needn't touch the focuser during your viewing session except to make minor adjustments or to change eyepieces.

Experience shows that the best area of the Moon to observe on any night lies at the terminator, the line separating the dark and sunlit lunar hemispheres. There the shadows are longest, accentuating the surface features. Because the position of the terminator changes nightly, it's worth coming back to the Moon each night. You'll be rewarded with different views of the craters, mountains, and lava plains.

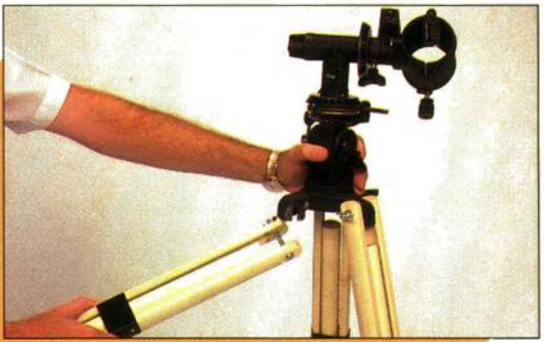
### Observing the Planets and Deep-Sky Objects

After you successfully view the Moon, your next-best object will be a planet. You need to be able to find the planet with your naked eye just as you did the Moon, so you can then locate it in the finderscope. The Sky Almanac section in each issue of ASTRONOMY will show you where to look. To the unaided eye Venus, Mars, Jupiter, and Saturn look like bright stars, though they don't twinkle as much, and they are visible even in large cities where it is difficult to see many stars because of street lights.

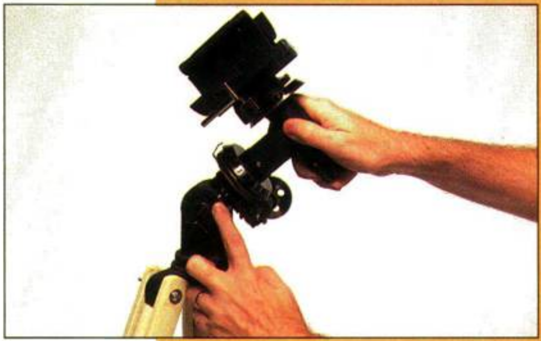
Centering the planet in the finderscope is more challenging than finding the Moon. Once you center it, the planet should be in the field of view of a low-power eyepiece in the scope. (If



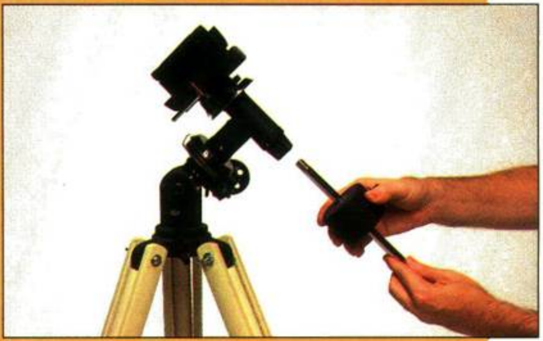
## ASSEMBLING AN EQUATORIAL SCOPE



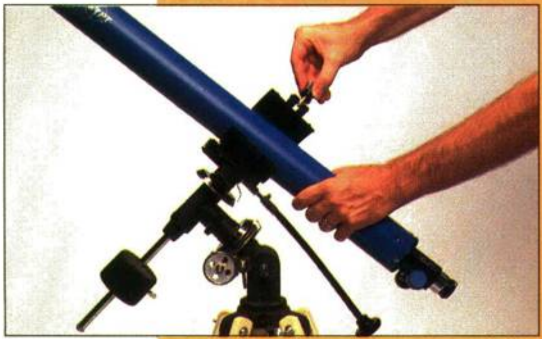
**THESE TRIPOD LEGS** have a bolt that fits into a slot in the mount. A center tray stiffens the tripod.



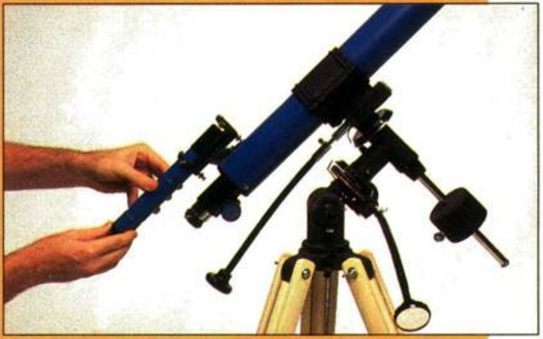
**LATITUDE ADJUSTMENT** is easy, but make sure the gear assembly is on the bottom.



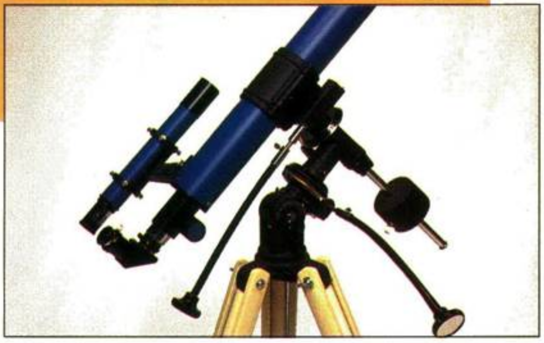
**THE COUNTERWEIGHT** screws into the declination axis. The weight balances the scope.



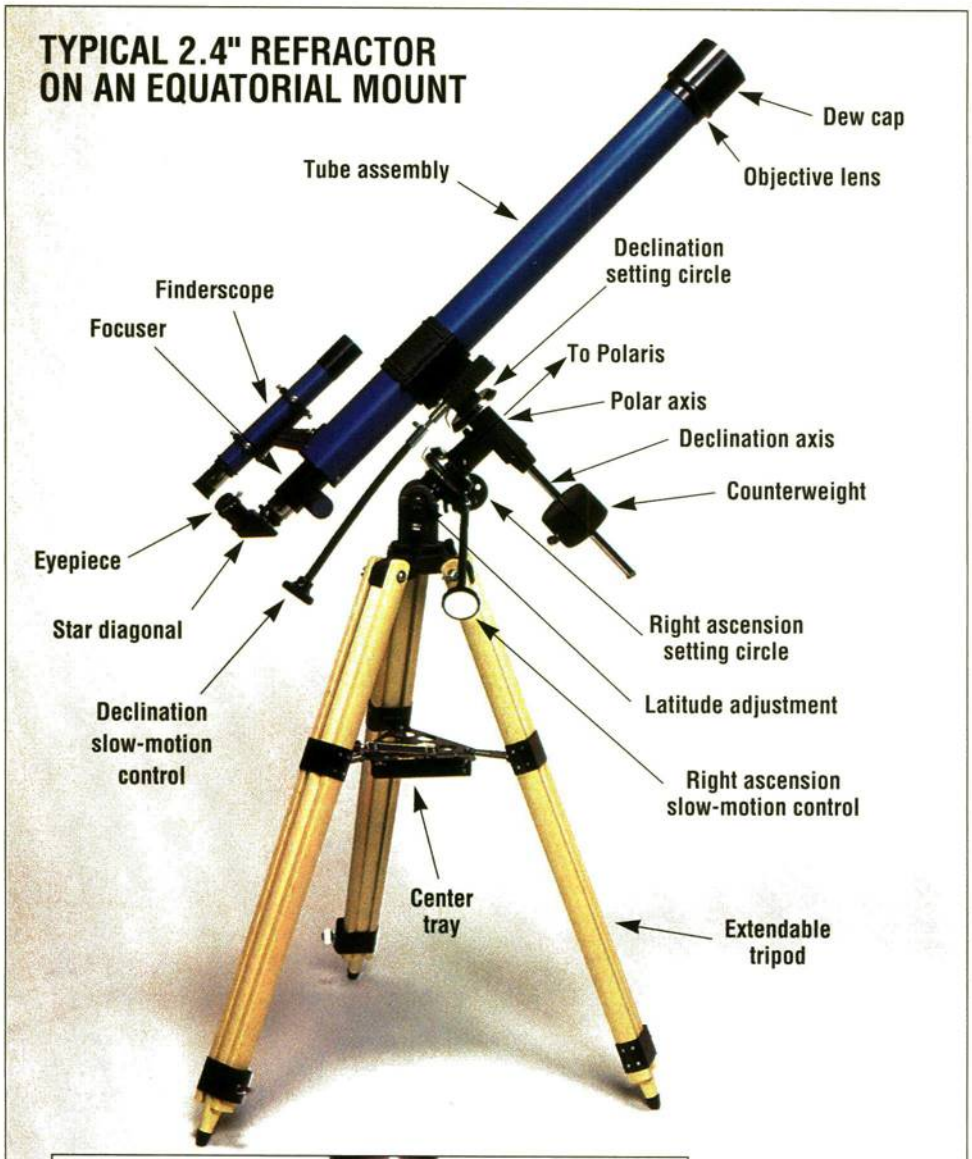
**THE TUBE ASSEMBLY** fits into the cradle. Place the tube so its balance point lies within the cradle.

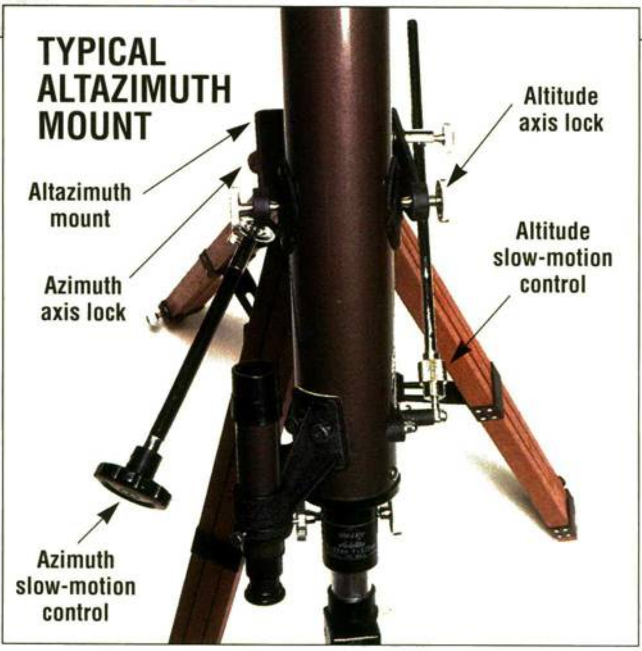


**TWO-RING FINDER** mounts permit accurate alignment of the finder with the telescope.



**AN EYEPIECE AND STAR DIAGONAL** make this scope ready for observing. Cover the optics when not in use.


TYPICAL 2.4" REFRACTOR ON AN EQUATORIAL MOUNT
Dew cap
Objective lens
Tube assembly
Declination setting circle
Finderscope
Focuser
To Polaris
Polar axis
Declination axis
Counterweight
Eyepiece
Star diagonal
Right ascension setting circle
Declination slow-motion control
Latitude adjustment
Right ascension slow-motion control
Center tray
Extendable tripod


TYPICAL ALTAZIMUTH MOUNT
Altitude axis lock
Altazimuth mount
Altitude slow-motion control
Azimuth axis lock
Azimuth slow-motion control

**LEARNING THE NAMES** of the telescope parts makes assembly of the scope easier.

it isn't, you need to realign your finderscope.) The planet will at first look like a small disk. Once you have the planet centered in the eyepiece, slowly adjust the focus knob to make it appear as small as possible.

With practice you will be able to see some features on the small disk. You can get better views if you switch to a medium-power eyepiece. To change eyepieces, first center the planet in the low-power eyepiece. Then gently remove it and insert your medium-power eyepiece. The planet should still be in the field of view, although it may not be centered or in focus.

When you look at Venus through your scope, you won't see its surface because clouds cover the planet. However, you can clearly see the phases of Venus change from full to new as the planet orbits the Sun. Venus is usually bright and often appears with a colored halo. That's not a feature on Venus, but the result of your refractor's focusing different colors at different distances from the objective lens. This effect, called chromatic aberration, is normal and occurs in all but the most expensive refractors.

Mars appears as a small reddish disk in the eyepiece. You can see changes in the planet's coloration when dust storms rage over the surface. You can also see the polar caps and large, dark features such as Syrtis Major (see "Observing the New Mars" in the November 1992 issue for a map of Mars). Be patient while observing planets. Wait for good seeing — times when the atmospheric turbulence dies down, briefly improving images. You want to be looking through the eyepiece at those moments when the planet's disk becomes crystal clear, revealing great detail. Mars' orbit, in combination with Earth's orbit, is such that the Red Planet is well suited for viewing for a few months every two years or so. This winter provides a good opportunity to view Mars.

The giant planet Jupiter appears as a large disk surrounded by four of its moons. You can easily see cloud bands and possibly the Great Red Spot in the planet's atmosphere. The Red Spot is a giant storm system that has lasted for over 300 years. Because Jupiter rotates once every 9.8 hours, the Red Spot is visible only when its hemisphere faces Earth. The four largest moons, called the Galilean moons (after Galileo who discovered them), are easy to detect. They revolve around Jupiter every few days and it is fun to track their motions from night to night. To help identify which satellite is which, use the chart included each month in the Sky Almanac section.

For many people, Saturn with its unmistakable rings is the most beautiful object visible in a telescope. With good seeing conditions, a 2.4-inch scope can sometimes reveal Cassini's division, an apparent gap in the rings. Saturn's largest satellite, Titan, is also visible with your scope.

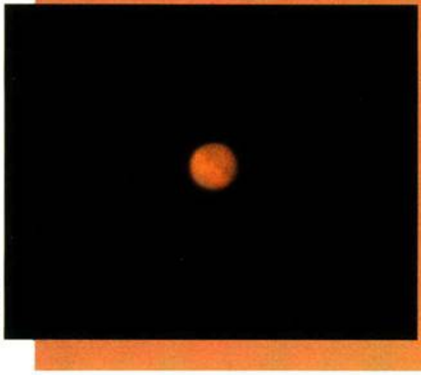
Don't think that's all you can see: double stars, bright nebulae, and galaxies are within reach of your scope. You can resolve double stars, two stars that appear close together. Often the two stars have different colors, adding to the interest of viewing doubles. Castor in Gemini, Rigel in

Charles Strickland

**DEEP-SKY OBJECTS**, such as the Orion Nebula, are visible in 2.4-inch scopes, using a low-power eyepiece.

Marc Duncan

**JUPITER'S ATMOSPHERE** provides a spectacle even in small scopes. The dark belts and bright zones occasionally change color or brightness.


Bob Wall

**MARS** appears as a small disk, but medium-power eyepieces will show the polar cap and other features.

Jacques Guertin and Bill Sorrells

**STAR CLUSTERS**, such as the Pleiades, show dozens or hundreds of stars. Use low power to see the entire cluster.

Orion, and Epsilon Lyrae are among the many doubles you can split with a 2.4-inch telescope.

The sky map found in the Sky Almanac section marks the location of many deep-sky objects with an "M" and a number. Start with easy objects such as M42, the Orion Nebula, and M35, an open star cluster. The galaxy M31 in Andromeda and the globular cluster M13 in Hercules are good objects. And try M1, the Crab Nebula, in Taurus. A massive star exploded here almost 1,000 years ago, creating this expanding gas cloud. All of these objects will probably make you want to find more, so a good star atlas is an important addition to your observing equipment. To preserve your night vision while using the atlas at the your scope, purchase a flashlight with a red bulb or filter.

### Improving Your Scope

As you learn to see more, you may want to upgrade your scope. Some simple additions will increase its abilities. For example, a motor drive added to an equatorial mount will automatically keep celestial objects centered in the eyepiece.

Stiffening a tripod can make your images shake less. Adding weight to the tripod and mount is one simple remedy. See "The Mount of Gibraltar" in the August 1988 Astronomy.

Many 2.4-inch scopes have finders that look big, but they often have restricted apertures as small as 5 mm. A larger finderscope with a double set of rings — the best kind of finder mount — costs about $40.

If your images are disappointing, check "Test Drive Your Telescope," in the May 1990 Astronomy, to make sure the problem doesn't lie with your objective lens. Chances are, however, that the problem lies in the eyepieces. Plan to spend $40 or more for each eyepiece. An upgrade to better eyepieces is also something you can take with you if you buy a larger telescope at some later date. Your telescope probably came with 0.965-inch diameter eyepieces, but you may want to buy standard 1.25-inch eyepieces so you can use them with a future, larger telescope. An adapter to fit these eyepieces to your 0.965-inch focusing tube costs about $15.

To improve your knowledge and skills, find out if there is an astronomy club in your area that holds star parties. At these events astronomy enthusiasts set up their telescopes, allowing you to look through them. A star party can give you ideas about different objects to view in your own scope, and it can make for a great family outing. □

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*Greg Beabout is an amateur astronomer living near St. Louis, Missouri.*

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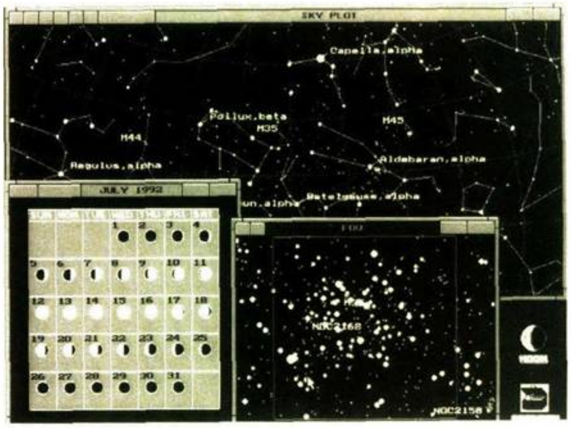
SKY PLOT
Capella.alpha
Pollux.beta
M35
M45
M44
Regulus.alpha
Aldebaran.alpha
JULY 1992
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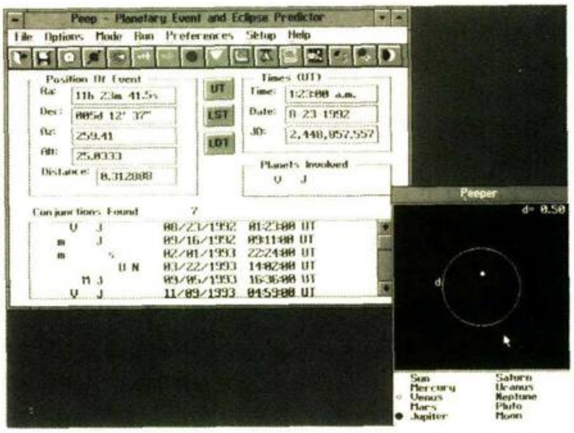
Peep - Planetary Event and Eclipse Predictor
File Options Mode Run Preferences Setup Help
UT
LST
LDT
Peeper
d= 0.50
d
Sun
Mercury
Venus
Mars
Jupiter
Saturn
Uranus
Neptune
Pluto
Moon

Position Of Event
Ra: 11h 23m 41.5s
Dec: 005d 12' 37"
Az: 259.41
Alt: 25.0333
Distance: 0.312000

Times (UT)
Time: 1:23:00 a.m.
Date: 8 23 1992
JD: 2,448,857.557

Planets Involved
V J

```
Conjunctions Found        7
     V  J              08/23/1992  01:23:00 UT
   m    J              09/16/1992  09:11:00 UT
   m      S            02/01/1993  22:24:00 UT
            U N        03/22/1993  14:02:00 UT
      M J              09/05/1993  16:36:00 UT
     V  J              11/09/1993  04:59:00 UT
```

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# PERSEIDS PEAK DESPITE MOON

August 1992 didn't offer favorable conditions for the most popular annual meteor shower. On August 11/12, the peak night for watching Perseid meteors, a nearly Full Moon bathed the sky in reflected sunlight. (The Perseid shower is a spectacular astronomical event when the Moon is absent and the sky is dark.) Despite the moonlight, however, observers watched and photographed an impressive shower that hurled plenty of bright meteors overhead.

"Reports from Europe, relayed by A. Mizser, Hungarian Astronomical Association, and P. Jenniskens, Dutch Meteor Society, indicate very high visual Perseid activity," wrote Brian G. Marsden on August 14. Marsden, of the Smithsonian Astrophysical Observatory, had been monitoring Perseid activity to see whether it would rise sharply, perhaps indicating the return of Comet Swift-Tuttle, the parent body of the Perseid meteor stream, last seen in 1862. Indeed, not only was the shower unusually active in 1992, but on September 27 a Japanese astronomer recovered Swift-Tuttle (see story on page 66).

Some amateur astronomers confirm the reports of an active Perseid shower. "The Perseids apparently produced a brief, intense meteor display," says Joe Rao of Flushing, New York. Rao and many friends listened for meteor activity on amateur radio equipment, which allows counting meteors by their interference in the radio signals. "This was one of the most active years in the 30 years I've been listening," says Doug Allen of Woodland Park, Colorado. Shelby Ennis of Elizabethtown, Kentucky, also noted unusually high radio interference, as did Emil Pocock of Lebanon, Connecticut.

Visual observers had a field day with the Perseids and didn't seem to mind the moonlight. Ten people from the Edmonton, Alberta, area traveled to the Blackfoot Recreation Area 16 miles east of Edmonton, Alberta to view the shower. "On August 11/12 we saw 344 Perseids and 30 other meteors over 5 hours and 23 minutes," reports Russ Sampson. Many of the meteors the Edmonton group observed left trains that remained visible as long as a minute. "We were very surprised at the number of meteors observed before local midnight. It seemed that a burst occurred early and then the shower tapered off, only to rise sharply in activity in the early morning hours."

Although the sky hazed over on August 11/12, at Naramata, British Columbia, Ken Hewitt-White was able to observe the shower for about an hour. "I saw 30 Perseids and 3 other meteors, of which an unusually large number appeared yellow-orange," Hewitt-White reports. "It was a good year for the Perseids despite the Full Moon."

George W. Gliba of Greenbelt, Maryland, began observing the shower a number of days before the peak. On August 2, while at the Stellafane convention in Springfield, Vermont, Gliba recorded all the meteors he saw. "Over three hours I saw 72 meteors, 27 of which came from the Perseid radiant," says Gliba. "The others were as follows: 23 sporadics, 17 Delta Aquarids, 4 Alpha Capricornids, and 1 Kappa Cygnid. It was quite a tally."

Not all of the excitement centered on the Perseid shower. "On August 20 I witnessed an unusually high number of meteors associated with the Kappa Cygnid shower," says Ray Grasshoff of Austin, Texas. Although little known, the Kappa Cygnid shower typically produces 3-5 meteors per hour on the peak date of August 20. The meteors are slow moving and some can be quite bright. Skywatchers have observed the shower since the year 1042.

"I was just south of Albion, California," says Grasshoff, "and I went outside simply to gaze at the stars for a few minutes. The Andromeda Galaxy was easily visible rising in the northeast. I could see 5th-magnitude stars without any trouble. Within about 15 minutes of casual observing I saw five meteors, and I soon realized that they could be traced back to near Deneb, toward the Kappa Cygnid radiant. My observations suggest a much higher rate than 3-5 per hour for the 1992 Kappa Cygnid shower."

Have other ASTRONOMY readers observed the Kappa Cygnids or any other little-known meteor shower? If so, we'd like to hear from you. ☐

---

*ASTRONOMY wants to hear about your observations of the sky. Send reports, sketches, and photographs to: David J. Eicher, ASTRONOMY, P.O. Box 1612, Waukesha, WI 53187.*

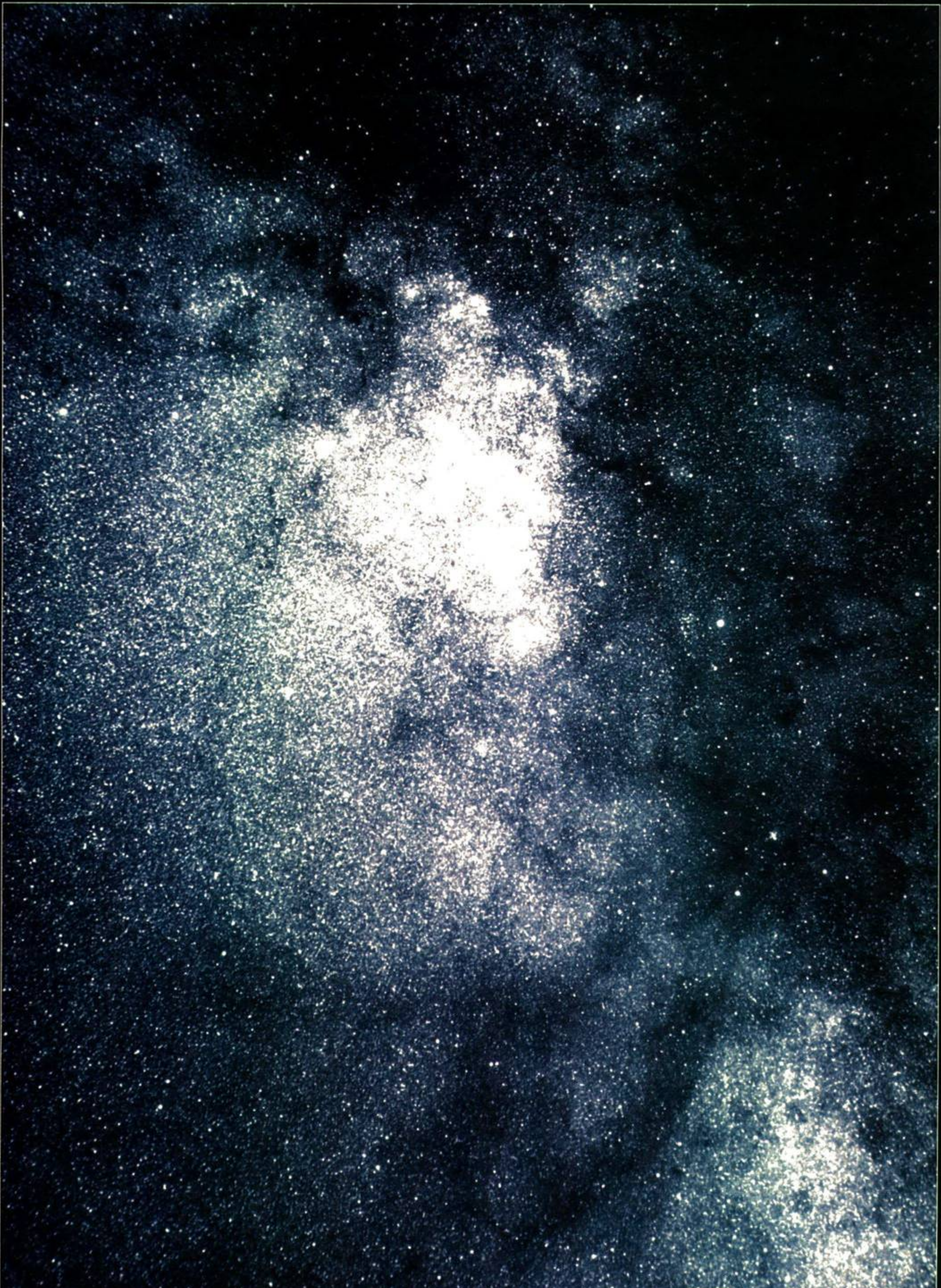
**THE PERSEIDS PERFORMED WELL** in 1992 despite a bright Moon's presence in the sky (right). Photo by Russ Sampson. California astrophotographer Ronald E. Royer caught a Perseid as it whizzed past the California Nebula and Pleiades star cluster (below).

# SPLENDOR OF THE STAR CLOUDS

The beauty of the summer Milky Way has now faded, replaced by a new set of Milky Way objects in the winter sky. Before the Scutum Star Cloud bade us farewell, Chris Cook of Long Beach, California, photographed the region with a telephoto lens (opposite page). Cook's photo of the cloud wins this month's $100 "Best Astrophoto" award.

Last summer observers at the Texas Star Party witnessed the splendor of the star clouds and the many deep-sky objects lying within them. Andy Saulietis used a Photometrics STAR I CCD camera and a 16mm fisheye lens to record the scene at last year's party in Fort Davis, Texas (below).

Other summer observing activities ranged from the solar system to the deep-sky. To celebrate seeing his 1,000th aurora, Jay Brausch of Glen Ullin, North Dakota, made a self portrait under the auroral light (bottom right). More distant sights included the Dumbbell Nebula in Vulpecula, photographed in tricolor by Bill and Sally Fletcher (left), and Nova Cygni 1992, captured by Ronald E. Royer (bottom left).



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- ★ The Grand Prize will be awarded once from all entries.
- ★ First, Second and Third prizes will be awarded three times: once from the November 1992 entries, once from the December 1992 entries and once from the January 1993 entries.
- ★ Send in the Official Entry Form from the November 1992, December 1992 and January 1993 issues of ASTRONOMY and triple your chances of winning!
- ★ If the Official Entry Form is missing from this magazine, send a postcard with your name, address, home phone number and this magazine's issue date to: ASTRONOMY Sweepstakes, P.O. Box 1612, Waukesha, WI 53187-1612. Cards must be postmarked by the last day of the month of the cover date of this issue. Entries are limited to one per person per month.

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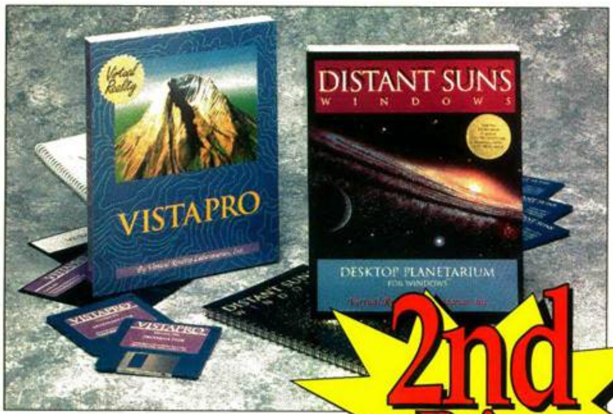

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**2.** Entries are limited to one per person per month. To be eligible for monthly prize awards, entries from the November issue must be postmarked by November 30,1992, entries from the December issue must be postmarked by December 31,1992 and entries from the January issue must be postmarked by January 31,1993. Monthly prizes will be selected in December 1992, January 1993 and February 1993. All entries must be postmarked by January 31, 1993 to be eligible for the Grand Prize, to be awarded in February 1993. Monthly prize winners will become ineligible for future monthly awards, but will be eligible to win the Grand Prize. All entries qualified under these rules will be eligible for the Grand Prize.

**3.** Winners will be selected in random drawings and decisions are final. Winners will be notified by mail and/or telephone. Any prizes returned as undeliverable will be awarded to alternate winners. Chances of winning are determined by the total number of entries received.

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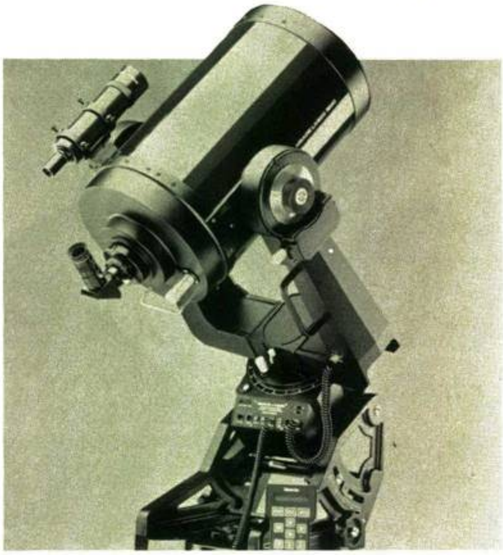

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See pages 90 – 91 for contest rules.

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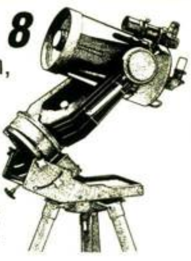

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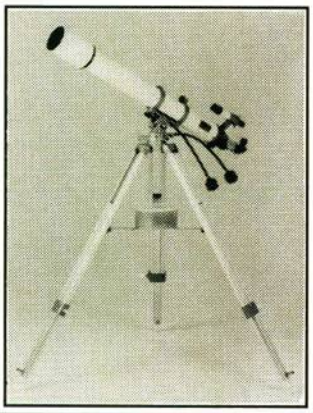

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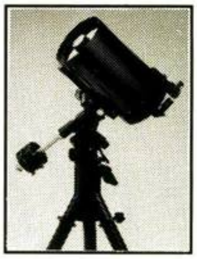

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# BASHING THE BIG BANG

*Masters of Time,* by John Boslough, (Addison-Wesley Publishing Company, 1992), ISBN 0-201-57791-7, 266 pages, hardcover, $22.95.

*Masters of Time* refers to cosmologists. The book describes the current status of the debate on cosmological models, at least prior to the recent discovery by the Cosmic Background Explorer satellite of the fluctuations in the cosmic microwave background radiation. Boslough presents both astronomical and particle physics discoveries relevant to current testing of ideas central to big bang models. Unfortunately his approach to the topic is not as unbiased as he expects scientists to be.

Boslough seems set on bashing big bang cosmologies rather than providing a setting for a rigorous debate on the successes and inadequacies of these theories. He also tries to provide a personal view of the present scientific confrontation by including interviews with, stories about, and descriptions of leading scientists. Too often these biographical notes, like his scientific descriptions, border on caricature.

His treatment of the fifth force — an antigravity force physicists believed they had discovered in 1986 — makes scientists into buffoons, first for their flurry of activity to prove or disprove this idea and then for showing how poorly they truly understood gravity. Boslough's description does not describe accurately the scientific process nor researchers' understanding of gravity. Rather his descriptions — or lack thereof — of the fifth force and other areas of physics and astronomy purposefully cast doubt on scientists' understanding of these areas in order to tacitly cast doubt on big bang theories.

Undoubtedly, the big bang has difficulties, as do all young theories. The existence of dark matter has cosmologists stumped, for example. And if Halton Arp is correct, some quasar redshifts are unrelated to their distances. But some anomalous redshifts do not mean that all redshifts are unrelated to distance and that astronomers must throw away the Hubble redshift law as Boslough seems to suggest. That way doesn't lie along the path of science any more than ignoring Arp's claims does. Unfortunately, Boslough is so intent on showing that big bang theories aren't perfect that he doesn't uniformly apply the skepticism needed in science.

Read this book if you want to learn about current debates in those areas of astronomy and particle physics bearing upon cosmological models. But beware — the treatment is not uniform and does not provide the unbiased viewpoint necessary for an informed opinion about the status of big bang cosmologies. — *Dave Bruning*

### Solar System

*Dictionary of Minor Planet Names,* by Lutz D. Schmadel, (Springer-Verlag, 1992), ISBN 0-387-54384-8, 687 pages, acid-free paper, hardcover, $59.

This dictionary results from a study commissioned by the International Astronomical Union into the origin of names of the minor planets. A short introductory text describes the rules for naming a minor planet. Most of the rest of the book lists the minor planets in numerical order up to minor planet 5012, describes the circumstances of the object's discovery, and gives background information about its name. Eleven appendices round out the data about the minor planets, listing discoverers (in alphabetical order), special groups of asteroids such as the Apollos and Amors, and minor planet names of uncertain origin. An index of names helps to locate the appropriate reference in the text.

### Deep-Sky Observing

*Seeing the Deep Sky,* by Fred Schaaf, (John Wiley and Sons, 1992), ISBN 0-471-53068-9, 206 pages, acid-free paper, softcover, $14.95.

This companion volume to *Seeing the Sky* and *Seeing the Solar System* offers 35 observing projects and indoor activities to help you better understand stars and galaxies. Half of the projects examine the physical nature of stars and their motions. A dozen projects explore bright nebulae, star clusters, and galaxies. While some observing projects, such as the observation of variable stars, require only the naked eye or a pair of binoculars, others require a telescope.

### Other Books Received

*Modern Astronomy: An Activities Approach,* by Mary Kay Hemenway and R. Robert Robbins, (University of Texas Press, 1991), ISBN 0-292-75133-8, 228 pages, acid-free paper, softcover, $24.95. Laboratory manual for college students. ☐

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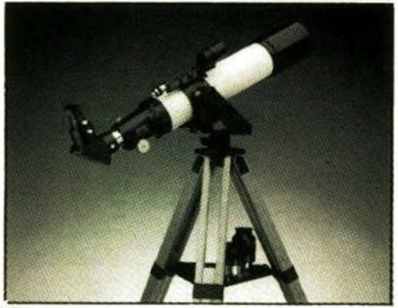

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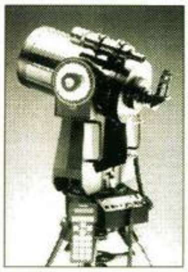

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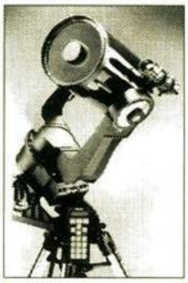

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| #8 Lt. Yellow, #11 Yellow-Green, #12 Yellow, #21 Orange, #23A Lt. Red, #25A Red, #38A Dark Blue, #47 Violet, #56 Lt. Green, #58 Green, #80A Blue, #82A Lt. Blue | **@12.95** |
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# NEW VISTAS FROM CD-ROMS

ASTRONOMY: Darla Gawelski

Compact disk read only memory (CD-ROM) has many applications in astronomy, including image and catalog storage. Each disk is 12 centimeters in diameter and can hold up to 700 megabytes of data. Two things kept CD-ROMs from common use by microcomputer astronomers until recently: CD-ROM drives were slow and expensive and not many data sets were available on CD-ROMs. Neither problem remains an issue. Drives now sell for under $300 and can access data on average in 300 to 400 milliseconds, about the time it takes to access data on a floppy disk. And many data and image sets are now available to keep microcomputer astronomers happy and busy.

Information contained on CD-ROMs ranges from star catalogs such as the *Hubble Guide Star Catalog* to images of astronomical objects. CD-ROMs are an economical means of producing catalogs of astronomical objects. A book, or series of books, listing the almost 19 million objects in the *Hubble Guide Star Catalog* would cost hundreds of dollars. But the CD-ROM version sells for as little as $29.95. A floppy disk can hold only 8 or 9 images that use 200 by 200 picture elements, or 40,000 pixels, while a CD-ROM holds over 17,000 such images. Even access isn't a problem; both IBM PC-compatibles and Macintosh computers can read the data contained on a CD-ROM.

The issue is no longer whether CD-ROMs are a useful tool, but one of where to obtain them. The *Hubble Guide Star Catalog* (version 1.1) is available from the Astronomical Society of the Pacific, 390 Ashton Avenue, San Francisco, CA 94112, or phone (415) 337-2624. Two versions of the catalog are available: a data-only version costs $29.95 and a version with programs to display text information on IBM PC-compatibles and a plot of star positions on Macintosh computers costs $59.95. Shipping and handling is an additional $6 for the data only version and $8 for the data plus programs version.

The Astronomical Research Network and Hopkins Technology distribute images of planets and deep-sky objects on CD-ROMs. The *Amazing Universe*, a single CD-ROM costing $79.95, has 101 images of planets and deep-sky objects. It also includes software for simple image processing and enhancement. Write Hopkins Technology at 421 Hazel Lane, Hopkins, MN 55343-7116 or phone (612) 931-9376. *Voyage to the Planets* and *Voyage to the Stars* comprise an eight volume set of CD-ROMs produced by Astronomical Research Network, 206 Bellwood Avenue, Maplewood, MN 55117 [phone (612) 488-5178]. Each CD-ROM costs $149.95 and includes simple image processing and enhancement software.

Astronomical images and catalogs are also available from the National Space Science Data Center (NSSDC). *Selected Astronomical Catalogs, Volume I* contains 120 standard catalogs such as the *Bright Star Catalogue* and *NGC 2000.0*, as well as hard-to-find catalogs such as Gliese's *Catalogue of Nearby Stars*. Each disk in the two CD-ROM set contains all of the catalogs. The data appear on one disk in ASCII format and on the other in the Flexible Image Transport System (FITS) format. Additional text files readable by a text editor explain the format of the catalogs and list the content of every data file.

NSSDC also offers 12 image and data sets on CD-ROM. These include Comet Giacobini-Zinner (1 disk), Comet Halley (23 disks), Infrared Astronomical Satellite Sky Survey Atlas (4 disks), Magellan mission to Venus (52 disks), pre-Magellan (1 disk), Viking Orbiter Images of Mars (4 disks), Uranus (3 disks), Saturn (2 disks), Jupiter (3 disks), Neptune (4 disks), Solar Variability Affecting Earth (1 disk), and the Space Science Sampler (2 disks).

NSSDC CD-ROMs cost $20 for the first disk in a data set and $6 for each additional disk in the set. Shipping and handling costs $2.50 for domestic orders and $10 for foreign orders. Place orders originating in the United States with NSSDC, Code 933.4, Goddard Space Flight Center, Greenbelt, MD 20771, and orders from outside the United States with World Data Center A for Rockets and Satellites, Code 930.2, Goddard Space Flight Center, Greenbelt, MD 20771, USA. For additional information or a current price list, phone (301) 286-6695 or FAX (301) 286-4952. — *Dave Bruning*

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### October: Computer Learning Month

The Computer Learning Foundation designates October as Computer Learning Month and holds several contests. Grand prize winners this year received IBM PS/2 Model 25 computers. We received notice of this year's contest too late to announce it. Write the Computer Learning Foundation, Dept. ED92, P.O. Box 60007, Palo Alto, CA 94306-0007 to receive their annual publication and notification of next year's contest.

### Bulletin Board Sysops Please Contact Us

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| Zoom Ocular (8.4-21mm) Ortho | *only* **99.95** | | |
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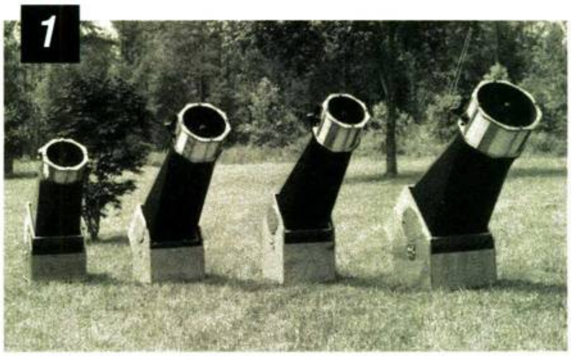
## New Astronomy Products



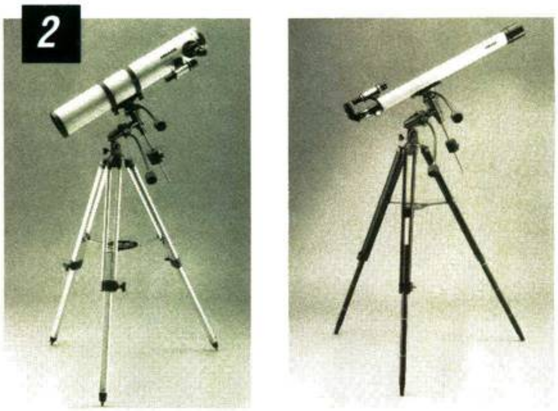
1

### New Series of Dobsonian Reflectors

Starstorm custom Dobsonian telescopes feature a rigid construction and premium optics fabricated by M. Leon Knott. The telescopes are available in a range of f/ratios and in apertures from 12.5 to 20 inches. The scopes break down into smaller components that nest together for ease of transport and storage. Assembly time is 5 minutes. A "through-bolt" upper assembly system is said to eliminate the image shift and defocusing normally seen in cantilevered upper tube assemblies. The tube is fully baffled and the mirror can be covered at all times other than during viewing. Woodwork is of cabinet quality and the finish is protected for durability under harsh use.

Also available (not shown): the Astro-Knott Universal Tripod, a cabinet-quality wood tripod suitable for numerous types of telescope tube assemblies and binoculars.

*Starstorm Optical, 1021 S. Revere, Mesa, AZ 85210, (602) 461-1758. Dobsonian telescopes: 12.5": $1,400; 20": $3,500. Call or write for prices on other sizes. Universal Tripod: $200.*



2

### New Entry-Level Telescopes from Meade

The Model 4500 (left) is a reflector telescope that employs an overcoated primary mirror with a diameter of 114 mm (4.5") and a focal length of 900 mm (yielding an f/ratio of f/8). The telescope features an equatorial mount with slow-motion controls and setting circles on both axes and an adjustable-height aluminum field tripod with eyepiece tray. Standard accessories include a 1.25"-diameter 25mm Modified Achromatic eyepiece (for 36x), a 1.25-inch rack-and-pinion focuser, and a 6x30 finderscope.

The Model 285 (right) is a 60mm refractor telescope with a focal length of 900 mm (yielding an f/ratio of f/15). It features a multicoated achromatic lens, 0.965" rack-and-pinion focuser, hybrid (0.965"-to-1.25") star diagonal, 6x30 finderscope, and two 1.25"-diameter Modified Achromatic eyepieces — a 25mm for 36x and a 9mm for 100x. The Model 285 uses the same equatorial mount (including slow-motion controls and setting circles) as the Model 4500, but with a hardwood tripod.

*Meade Instruments Corporation, 1675 Toronto Way, Costa Mesa, CA 92626, (714) 556-2291, FAX (714) 556-4604. Model 4500: $399; Model 285: $329.*

### 3 Tele Vue Gibraltar Mount

The Gibraltar is a computer-compatible altazimuth mount for Tele Vue refractors or other telescopes with tube diameters of 5 inches or less. The mounting head is made of anodized aluminum and features large bearing surfaces that provide smooth Dobsonian-like motions with minimum vibration at high powers. The head is pre-drilled to accept optical encoders for digital setting circles such as JMI's NGC computer series. The tripod legs are solid ash.

*Tele Vue Optics, 100 Route 59, Suffern, NY 10901, (914) 357-9522. $595. (Tele Vue Genesis refractor, NGC-MAX computer, and encoders shown with mount are not included.)*

### 4 Long-Eye-Relief Eyepieces from Celestron

Every model in the LV series of Vixen eyepieces features a long 20 mm of eye relief, the first in a complete series of eyepieces to do so. Available in ten focal lengths from a low-power 30mm model to an ultra-high-power 2.5mm model, each LV eyepiece employs rare-earth lanthanum glass in one of the field lenses to keep aberrations to a minimum. All eyepieces have a barrel diameter of 1.25", except the 30mm, which is a 2"-barrel model. Apparent fields of view range from 45° to 50° and eyepiece design varies from 6 to 8 lens elements. All lenses are multicoated. The barrels have a soft rubber covering, fold-down rubber eyecups, and color-coded rings.

*Celestron International, 2835 Columbia Street, Torrance, CA 90503, (310) 328-9560, FAX (310) 212-5835. Contact local dealers for prices.*

### 5 Fully Electronic Flashlight

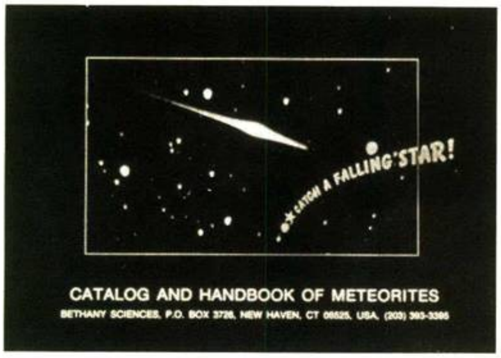
The E•ON flashlight uses three LED light sources and an electronic on-off switch, doing away with mechanical switches. Two versions are available: one with red LEDs for astronomy, and one with red and green LEDs (yielding an amber beam) for aeronautical use. The E•ON operates from a 9-volt battery and has a built-in battery status indicator.

*GDI, 8948 SW Barbur Boulevard, Suite 150, Portland, OR 97219, (503) 244-7492. $24.95.*

### 6 New Meteorite Catalog

The 1992/93 edition of the 24-page Bethany Science Catalog of Meteorites features a large selection of iron, stone, and stony iron samples, including rare and hard-to-find specimens as well as tektites and impact glasses.

*Bethany Sciences, P.O. Box 3726-A1, New Haven, CT 06525-0726, (203) 393-3395. $2, refundable with first order.*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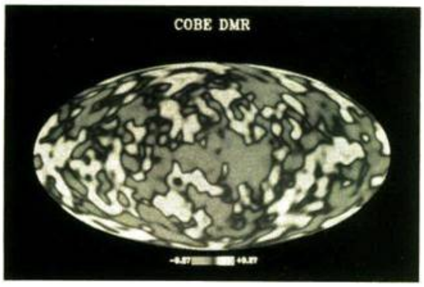
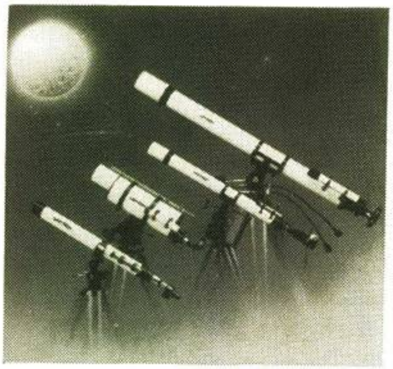


### 7 COBE Slide Set

This new set of 16 slides explains the findings from the Cosmic Background Explorer, the satellite whose detection of fluctuations in the radiation echo of the big bang made headline news in early 1992. The set is accompanied by a 16-page booklet written by astronomer Jay Pasachoff and COBE project scientist John Mather.

*Astronomical Society of the Pacific, COBE Set Orders, 390 Ashton Avenue, San Francisco, CA 94112. $24.95. Price includes shipping and handling in the U.S. Outside the U.S. add $3 and remit in U.S. funds.*

[continued on page 106]



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"On the Moon and Jupiter, the Odyssey 8 showed as much detail as several 8" Schmidt-Cassegrains nearby."
David McGough, Millington, N.J.

"It is worth twice what I paid, but please don't raise the price. I want to get my son one in a few years."
Tom Johnston, Boulder, Colo.

**10.1 inch $345.00**

"Careful star-testing of the 10.1" Odyssey Compact I received last March and of the 10.1" my neighbor Doug Barnes picked up in mid-October suggests a high level of quality control which is astonishing. Diffraction patterns are virtually interchangeable, and both scopes show textbook optical results (both in-focus and out-of-focus)."
Lee Johnson, Coquitlam, B.C. Canada

**13.1 inch $575.00**

"In amateur astronomy for over 35 years and I have seen my share of all kinds of telescopes, good and bad. To say the least, the Odyssey 1 outperforms any thing that I have seen!!"
Richard Ziegler, Maumee, Ohio

"There is not another telescope of equal size in our club that can touch the clear image and ease of operation that Odyssey 1 provides."
Mark Davenport, Pinellas Park, Fla.

**17.5 inch $1150.00**

"I've only had a chance to view once so far, but am thoroughly thrilled with it. Viewing from a (Santa Barbara, Ca.) residential front yard, the Orion Nebula was indeed a treat – reddish tinges on the predominating green, with many subtle wisps and lanes very clear. The Andromeda Galaxy was surprisingly bright, as was its companion." David Broad, Santa Barbara, Ca.

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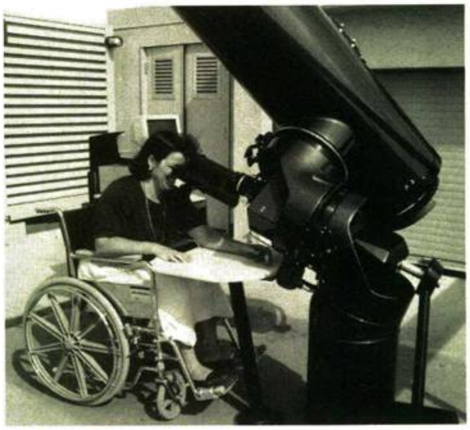
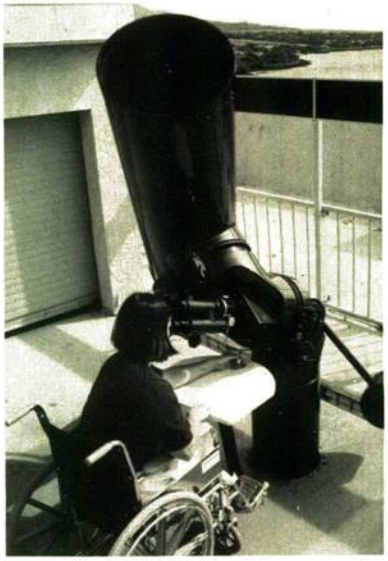
### 8 Project STAR Catalog

Project STAR (Science Teaching through its Astronomical Roots) offers low-cost materials to support hands-on science education. The activity kits have been developed by scientists at the Harvard-Smithsonian Center for Astrophysics in partnership with high school and university astronomy teachers. The new Project STAR catalog features a simple refracting telescope kit, a celestial sphere kit, a variety of holographic diffraction gratings, a spectroscope kit, an activity book, and other low-cost items. The catalog is free.

*Learning Technologies Incorporated, 59 Walden Street, Cambridge, MA 02140, (800) 537-8703, FAX: (617) 547-2686.*





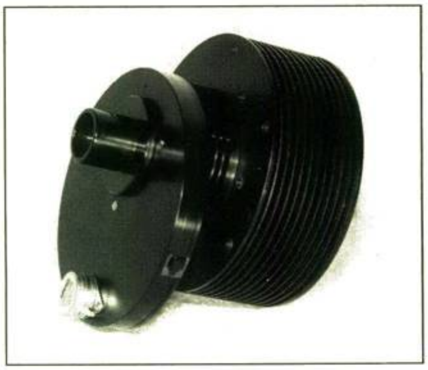
### 9 A Telescope for Public Observatories

Alaska Applied Sciences offers a custom-built 16-inch telescope on a Springfield-style mount suitable for public observatories and facilities looking for a wheelchair-accessible telescope. The telescope shown here was designed and built for the Hyatt Regency Hotel on Maui, Hawaii. The telescope is computer-guided and features a stationary focus and binocular eyepieces for comfortable viewing from a seated position no matter where the telescope is aimed. A joystick allows the viewer to slew the telescope, and the computer plays digitized soundtracks that describe the current object. Contact Alaska Applied Sciences for more details on this unique telescope design.

*Alaska Applied Sciences, Box 020993, Juneau, AK 99802, (907) 586-1426, FAX: (907) 586-1423.*

### 10 Computerized Filter Wheel

The CompuScope FW-1 is a computer-controlled filter wheel suitable for photometry and color CCD photography. The FW-1 uses a precision miniature motor and servo electronics for filter changes and can hold up to eight filters at once. All filters and electronics are housed in a lightweight casing so the filters are never exposed. The unit is 5.9" in diameter and less than 1/2" thick. Connection to an IBM-compatible computer is through the printer port. (Mac users inquire.) Adapters are available for various CCD cameras (shown with ST-6 camera and optional 1.25" adapter).



*CompuScope, 3463 State Street, Suite 431, Santa Barbara, CA 93105, (805) 687-1914. $995, complete with electronics and computer interface. UBVRI filters for CCD-based photometry are $70 each. Adapter for 1.25" focuser is $60. Other filters and adapters available.*

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Computerized setting circles are changing the way thousands of amateur and professional astronomers see the sky. With no need for polar aligning or entering complicated site data, these units easily guide the user to any of hundreds or even thousands of objects!

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But we don't just do the "oldies". We are consistently the first to outfit the newest telescopes. Some of our most recent endeavors include mountings for the Celestron G-11, Meade Starfinder, and Tele Vue Mount of Gibraltar.

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Like our customers, we're not satisfied with the cheapest and simplest-to-make installation either. In designing each installation, we strive to maintain the qualities which have long separated JMI from the rest of the crowd.

Because of our superior engineering, pre-assembly, and actual on-scope testing, most of our installations require only 15-20 minutes without drilling or tapping. We even provide allen wrenches and a battery - about the only tool you'll need is a screwdriver!

With your unit installed, you will still have full movement of your telescope without the worry of damaging an expensive encoder. We design our cables to allow at least one full rotation on each axis - and should you ever snag a wire you can rest assured that you won't destroy an encoder because our industry-unique phone-type connectors are more reliable and user-friendly than the in-line type our competition uses.

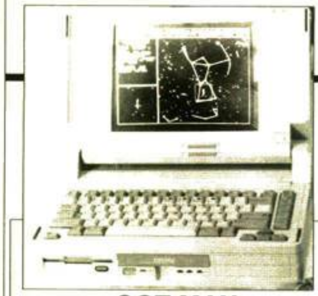
Of the few telescope models outfitted by others, our installations feature an equal or higher resolution - in some cases by a factor of two or more!

Our customers are also concerned about appearance. Our encoder mountings are designed to appear as pleasing as possible - in some cases they may even enhance the telescope's appearance! And we provide a custom made computer unit holder so you don't have to resort to tape or Velcro™.

We will be happy to send you a free copy of our encoder installation instructions for one or more telescopes you own. And if yours is not one of the 70 plus models outfitted, we can send you information on our kit for those with some mechanical aptitude.

Or call to speak with one of our seven amateur astronomers.

## JMI



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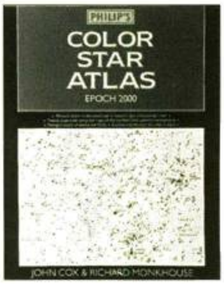
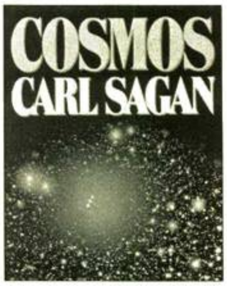


**Color Star Atlas**
The world's user-friendliest star atlas shows all stars visible to the naked eye (down to magnitude 6.5) in color on 20 wide-field charts. Includes hundreds of deep-sky objects and enlarged, detailed charts showing interesting regions such as the belt of Orion, the Hyades, the Southern Cross, and the tail of Scorpius. Includes a guide explaining star colors and what they mean. By John Cox and Richard Monkhouse. 11 x $15^{1}/_{2}$, 40 pgs., 4 color photos and 54 illus., sftbd. #18038........................................................**$19.95**



**Cosmos**
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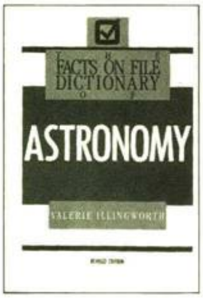

**The Facts on File Dictionary of Astronomy**
A necessary reference for every astronomer's bookshelf. More than 2,300 entries describe everything you need to know about the astronomy world, made clear through concise, simple language and illustrated with 85 line drawings. By Valerie Illingworth. $6^{1}/_{4}$ x $9^{1}/_{4}$, 437 pgs., hrdbd. #30013.........................**$24.95**

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Donald H. Menzel Jay M. Pasachoff

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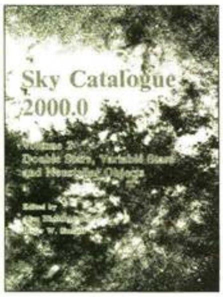

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Handy, hard-to-find data on thousands of astronomical objects, conveniently arranged. By Roger Sinnott and Alan Hirshfeld. 9 x 12, 700 pgs., 18+ b&w photos, 350+ illus., sftbd. **Vol. 1:** Stars to Magnitude 8.0. #30023....................................................**$39.95**
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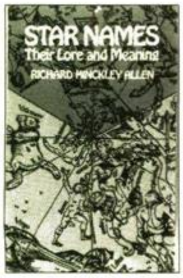

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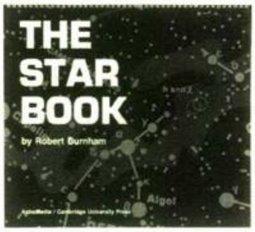

**The Star Book**
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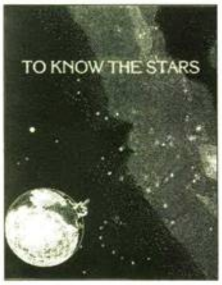

**To Know the Stars**
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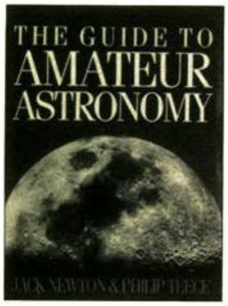
## Intermediate



**The Guide to Amateur Astronomy**
An introduction to the fundamentals of astronomy and how to get started observing. Includes observing projects, information on equipment and a detailed guide to astrophotography. By Jack Newton and Philip Teece. 7½ x 10, 326 pgs., 20 color and 173 b&w photos, hrdbd.
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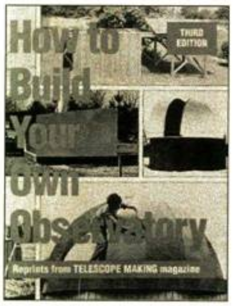
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THIRD EDITION
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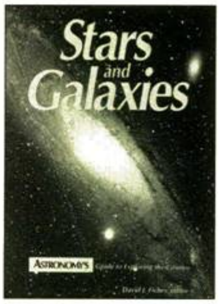

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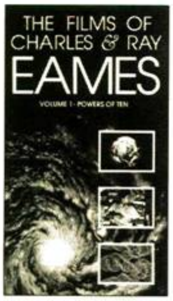

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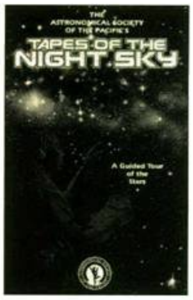
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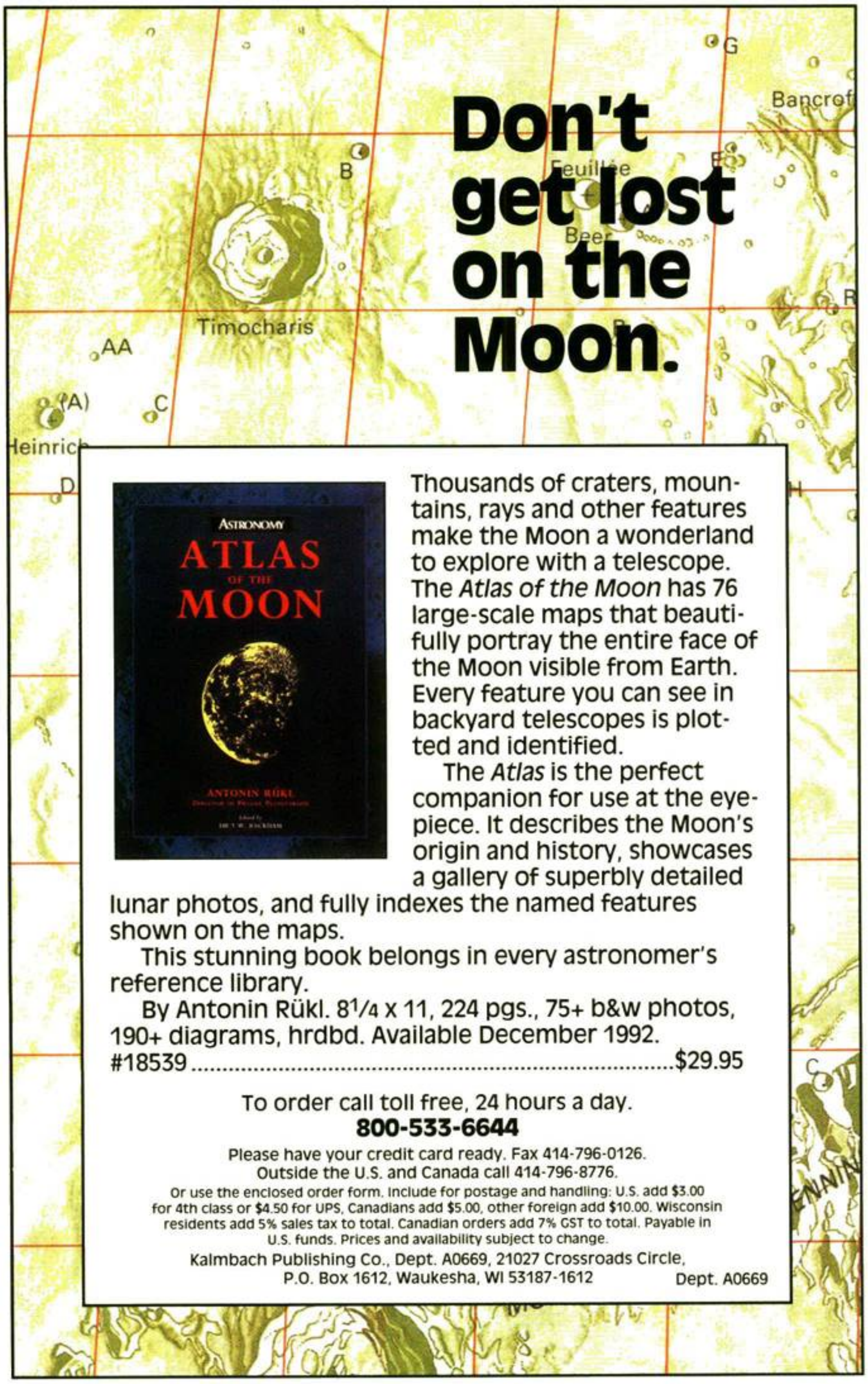

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By Antonin Rükl. 8¼ x 11, 224 pgs., 75+ b&w photos, 190+ diagrams, hrdbd. Available December 1992.
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## Meetings & Events

**February 15-21**
**9th Annual Winter Star Party**, Camp Wesumkee, Florida Keys, Florida. Sponsored by the Southern Cross Astronomical Society. Contact Bob or Sharon Grant, 5401 SW 110th Avenue, Miami, FL 33165. Phone: (305) 595-8778.

**March 17-19**
**Satellites and Education Conference IV**, West Chester University, West Chester, Pennsylvania. Sponsored by the School of Education, NASA, GE Astro Space, Pennsylvania Space Grant Consoritum, and the National Oceanic and Atmospheric Administration. Contact Nancy McIntyre, West Chester University, West Chester, PA 19383. Phone (215) 436-2323.

**March 20**
**2nd Annual Messier Night**, Lake Hudson State Recreational Area, Clayton, Michigan (cloud date March 27). Sponsored by the Astronomical Societies of Lenawee and Hillsdale Counties. Contact Astronomical Societies of Lenawee and Hillsdale Counties, P.O. Box 229, Hudson, MI 49247. Phone: (517) 448-7173 days or (517) 547-7402 evenings.

**April 10**
**Northeast Astronomy Form**, Rockland Community College, Suffern, New York (Exit 14B off I-287). Sponsored by the Rockland Astronomy Club. Contact Don Urban, Rockland Astronomy Club, 73 Haring Street, Closter, NJ 07624.

**April 5-7**
**Second Solar Astronomy Convention**, La Paz, Baja California Sur, Mexico. Sponsored by the La Paz Station of the Solar Astronomy Research Center. Contact Calle La Purisima 119, Colonia Bellavista, Codigo Postal 23050, La Paz, Baja California Sur, Mexico. Phone: 91-682-1-07-32.

**June 25-July 2**
**Kopernik Astronomical Society Trip**, Kitt Peak, Lowell Observatory, Meteor Crater, and Grand Canyon. Sponsored by the Kopernik Astronomical Society. Contact Kopernik Observatory, 30 Front Street, Binghamton, NY 13905. Phone: Jay Sarton (607) 772-0660. ☐

*Clubs, please submit announcements at least four months before the date of the meeting or event. Readers, when you write to organizations, include a self-addressed, legal-sized envelope with your request for information.*

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| Vixen 4 1/4" Alt Reflector | $179 |
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| Monocular 8x25 ... $37, 8x25 mini ... $64, 10x25 | $84 |
| Waterproof 7x50 10x50 ... $195 8X56 PRO | $135 |
| 10x50 PRO ... $118, 7x50 PRO ... $114, 12x50 PRO | $149 |
| Ultima 7x42 8x32 ... $172 ea. 8x56 | $185 |
| Ultima 7x50 mm, 10x50mm | ea $195 |
| 11x80M/C ... $288, 15x89M/C ... $293 20x80M/C | $297 |
| 20x100 MM GIANT | $849 |
| Fixed Focus 8x40 WA 7X50WA 10x50WA | $64 |
| BINOCULAR NECK STRAP (Wide) | $2 |

**OPTICAL TUBE ASSEMBLIES**

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|---|---|
| C80 C4 5 ... $279 SP6102 | $499 |
| SPC 6 | $379 |
| 8" Optical Tube Assem. (Blk or Orn) | from $545 |
| C11 ... $1649 C14 | $3899 |

**ULTIMA EYEPIECES**

| | |
|---|---|
| 5, 7. 5 12.5, 18, 24mm 2xBARLOW (1¼") | ea $62 |
| 30, 42mm (1¼") | ea $86 |
| 35mm (1¼") | $63 |
| 15 19 23mm WA (1¼") | ea $102 |
| 45 60mm 2" | ea $159 |
| 80mm 2" | $238 |
| OR 5, 6, 7, 9, 12mm (96") | ea $36 |
| KE 10mm 18 25 30 40 (96") | ea $29 |
| Zoom 6.5-18, 1 1/4" | $105 |

| | |
|---|---|
| Zoom 96" OR 8 4 21mm-DELUXE | $99 |
| 25mm K 1¼" Multi-Coated | $35 |
| Terrestrial Eyepiece 96" | $17 |
| OR 1¼" 5 6 7 9 12mm | ea $45 |
| PL 1¼" 26mm | $59 |
| Zoom OR 11/2" 8 4 21mm | $95 |
| 18 25mm 2" SPECIAL PURCHASE | ea $74 |
| Coma Corrector Photo-Visual 1 1/4" - 2" | $175 |
| Micro Guide Eyepiece | $133 |

**T-RINGS**

| | |
|---|---|
| (State Camera Make Model) All $10 EA OR (2) | for $18 |
| 2 1/4" Format | $159 |

**ACCESSORIES**

| | |
|---|---|
| AC Adapter (PEC) | $22 |
| Accessory Case | $43 |
| Barlow Lens 2x96" ... $29 1 1/4" | ea $39 |
| Barlow Lens 2x2" m/c (Giant) | ea $85 |
| Battery (Ill Reticule) (1.5V) | $2.95 |
| Binocular Tripod Adapter (small) ... $9 (large) | $14 |
| Car Batt. Adapter Ultima (PEC) | ea $19 |
| Car Window Mount | $33 |
| Carrying Case - Powerstar 8 Custom | $139 |
| Counterweight Bar Assem -8" ... $59 11" | $64 |
| Counterweight Set - 8" (Standard) | $48 |
| DC Inverter (110V) | $74 |
| Drag Erect Image - 45° 96" ... $42 45° 1 1/4" | $46 |
| 45° 96" to 1 1/4" DIAGONAL | $45 |
| DEC Motor - Powerstar Classic 8 | ea $92 |
| DEC Motor - 11" | $79 |
| DEC Motor C8 Sup C8 Classic 8 | $99 |
| DEC Motor (PEC) 8/11 | $92 |
| Deluxe Lat Adjuster (DLA) C8 | $30 |
| Dewstar (Lens Shade - 8") | $25 |
| Advanced Astro Master (ATM) | $489 |
| Advanced Astro Master (SP,/FORK) | $549 |
| Drive Corrector - Heavy Duty | $359 |
| Drive C8 Quartz Sing Axis | $195 |
| Quartz Dual Axis (C8) | $219 |
| Expanding Bushing - 96" to 1 1/4" | $14 |
| Filter (All Colors) 2" | ea $19 |
| Filters #1A 8 12 15 21 23A 25 38A 47 56 58 80A 82A 96ND 50% 96ND 25% 96ND 13% Polarizing | ea $10 |
| Filter Sets (Set of 6) ... $59 (Set of 12) | $118 |
| Filter - Series 5 or 6 (6 ea. in Set) | $55 |
| Filter Adapter - 96" ... $12 1 1/4" | $16 |
| Finderscope 8x20 for C90-erect image ... $54 BKT | $12 |
| Finderscope R/A 5x24 ... $39 5x24 STG ... $29 6x30 | $32 |
| Finder Bracket (Quick Release) 8X50 | $45 |
| 8x50 ... $49 16x70R/A w/pol ill | $189 |
| R/A w/Polar Align Reticule - 8x50 Ultima w/BKT | $144 |
| Focus Motor - C8, Classic 8, PWR STAR | $93 |
| Focus Motor (PEC) 8/11 11/14 | $98 |
| MFFT 55 | $129 |
| Image Corrector - 1 1/4" OR .96 | ea $24 |
| Large Accessory Ring (LAR) C90 | $21 |
| Lens Shade - C90 ... $54 C8 ... $25 C11 | $139 |
| LPR Filter (Nebular #2 ... $129 #3 ... $42 #5 | $79 |

| | |
|---|---|
| #7 ... $89, "A" ... $49, C" ... $75, "D" | $85 |
| Motor Drive-for C4 5 w/Dr Single Ax.-SP (DC) | ea $155 |
| Motor Drive S A (AC) Pol/Sp | $88 |
| Motor Drive w/Dr. Dual Axis SP (DC) | $253 |
| Multiple Ocular Holder 96" ... $49 1 1/4" | $130 |
| Off Axis Guiding System $127 Guider Body (Only) | $59 |
| Photo Tripod Adapter 8" | $50 |
| Photographic Tripod Deluxe Slow Motion Controls | $43 |
| Piggyback Mount 8" ... $33 11 14 | $54 |
| Piggyback Mount SPC 80 SPC 102 SPC6 | ea $39 |
| Polar Axis Finder w/Illum (for C4 5) | $51 |
| Polar Axis Finder - SPC6 - C80 | $66 |
| Polar Filter Set - 965 | $36 |
| Polarizing Filter Set - 1 1/4" | $42 |
| Porro Prism - 965 ... $39 Porro Prism 1 1/4" | $43 |
| Radial Guide Assy Off Axis | $109 |
| RFA (Rich Field Adap) | $79 |
| Refractor Accessory Ring | $18 |
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| Filter Set - Series 5 (six) ... $49 Series 6 (six) | $49 |
| Skylight Filter Model #1 (C90s) ... $31 #2 (8/11/14) | $36 |
| Solar Filter - C90 C102 C4 5 | $68 |
| 5" Off Axis - C11 ... $109, C8 ... $112, C60 C80 | $42 |
| Star Diagonal 1 1/4" w/Multicoatings | $39 |
| Star Diagonal (Mirror) 2" Deluxe Adjustable (PRO) | $219 |
| Star Diagonal 2" (Mirror) | $108 |
| Star Diagonal 2" - Multi-Purpose | $215 |
| Stereo Binocular Viewer | $418 |
| Super Polaris Half Pier | $105 |
| Super Polaris Mt & Tripod | $495 |
| Tangent Ass'y | $195 |
| 2 1/4" Camera Adapter (Specify 2 1/4" Camera) | $149 |
| T-Adapter C90, C5, C8, C11 | ea $22 |
| T-Adapterr - Refractors C4 5, C6, C60 | $39 |
| T-C 16mm Adapter ... $28, 6x6 | $58 |
| Table Top Mount - C65 | $20 |
| Tele Extender- Deluxe ... $38, Tele Extender | $22 |
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| VSP (Vibration Suppression Pads) | $40 |
| Visual Back - 1 1/4" (Eyepiece holder) | $26 |
| Wedge - C8 ... $85 Heavy Duty 8" ... $198 11/14 | $369 |
| Wedge UII (Heavy Duty) | $319 |
| Tilt Plate 0 Degrees | $75 |

**PUBLICATIONS**

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| Owners Manuals, Acc. Catalog | ea $5 |
| Binocular Buyers Guide Book by Alan Hale | $9.95 |
| Sky Maps ... $12 (Quantity Price) | $10 |
| Star Atlas (Northern Hem.) 2000.0 ... $16 Planisphere | $6 |

**MICROSCOPES-VIXEN**

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|---|---|
| #2106 ... $105, #2101, 2103, 2104 | ea $74 |
| #2108 ... $149, #2109 | $174 |

**MISCELLANEOUS**

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| Lens Caps ... ea $50 End Caps (SCH./CASS) | $1 |
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| Vogel - Digitrak Drives, Inverters-SPECIALS- | CALL |
| Questar Tripod H-D Field Model | $299 |
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| Glass-Full aperture 8 in. | $79 |
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| 2045 Spotting Scope | $386 |
| 2081 Spotting scope 8" f10 ... $719 f6 3 | $749 |
| 323 with Equatorial Mount | $368 |
| 390 90mm Alt.Z. W 1.25" Eyep. | $448 |
| 395 90mm Equit. W 1.25" EyeP | $498 |
| 2 4" (60mm) Alt. Refracting Telescope | $89 |
| 2 4" (60m) Equatorial Refracting Telescope | $149 |
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| Refractors - LARGER SIZES | CALL |
| 4 1/2" Reflecting Telescope | $239 |
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| 2080 f 6.3 MC/OG | $1129 |
| 2080 f10 MC/OG | $1099 |
| 2060 16" f/10 SCH/CASS (Spring '93) | CALL |

**BINOCULARS**

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|---|---|
| 11x80, 20x80 M/C ... $349, 7x42, 10x42 | $179 |

**ACCESSORIES**

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|---|---|
| Equatorial Wedge plus Tripod 2045 | $232 |
| Super Wedge 10" | $349 |
| Equatorial Wedge for Model #2080, #2045 | $85 |
| Equatorial Wedge for Model #2120 | $98 |
| Field Tripod for Model #2080, #2120 | $205 |
| Field Tripod for Model #2080(Oak) Any Color | $195 |
| Altazimuth Adp. for Field Tripod (#2080, #2120) | $18 |
| Fork Mount/Drive 4" ... $274 8" ... $624 10" | $724 |
| Deluxe Latitude Adjuster 2080 or 2120 | $25 |
| Setting Circle Illuminator System #2080, #2120 | $36 |
| #605 Magnetic Compass | $10 |
| Azimuth Control (for Field Tripods for 2080) | $15 |
| #603 DC Cord (25') w/cigarette plug | $16 |
| 1200A Electric Focuser | $118 |
| #671 Wide-Field Adapter System (WFAS complete) | $89 |
| Tele-Compresser Lens only (f5) | $39 |
| Tele-Compresser System comp w/Extender Tube | $54 |
| Eyepiece Extender Tube only | $18 |
| Off-Axis Guider Body only | $78 |
| Illum Ret Eyepiece Sys 1.25" 12mm ... $69, 9mm | $99 |
| Spotting Scope Adp.Plate 2120, 2080 | $52 |

**EYEPIECES**

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|---|---|
| Mod. Ach. (965) 9 12 25 40mm | $34 |
| Mod. Achromatic 1.25" 9,12,25,40mm | $37 |
| 1.25" Orthos 4mm, 6mm, 9mm, 12.5mm M/C | $41 |
| Sup Plossl 1 25" 6 4, 9 7, 12 4, 20, 26mm | $69 |
| 15mm | $59 |
| 32mm ... $88, 40mm, 1 25" | $84 |
| 56mm, 2" | $134 |
| 13 8mm Super Wide 1 25" | $119 |
| 18mm 1 25" ... $119, 24. 5mm 1 25" | $112 |
| 32mm 2" ... $177, 40mm 2" | $178 |
| 4.7mm 1 25" ... $134, 6.7mm 1 25" | $118 |
| 8. 8mm 1 25"/2" ... $138, 14mm 1 25"/2" | $172 |
| Rotary Multiple Holder 1 1/4" | $134 |
| Eyepiece Holder, 1 25" | $26 |
| #915 Diagonal Prism .965 (90°) | $36 |
| #917 Hybrid Diagonal Prism 955/1 25" | $36 |
| #918 Diagonal Prism .965/1 25" | $36 |
| #919 Diagonal Prism w/threaded Ring 1 25" | $40 |
| #929 2" Diagonal Mirror including eyepiece adapter with 1 1/4" Adapter | $84 |
| #930 Diag Mirror 2" OD Barrel for 2" Focuser Sleeve | $129 |
| #924 Erecting Prism 1 25" | $56 |
| #928 Erecting Prism System 45° | $46 |
| #912 Roof Prism 965, 908, 97D, 97E, 97ER | $49 |
| #931 Hybrid 45° Erecting Roof Prism .96 - 1¼" | $49 |

**FILTERS**

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|---|---|
| Photo Vis. Color Fil. & Pol. 1 25" All Col. Avail | ea $11 |
| Set of 6 Photo Visual Color Filters (.96 Or 1 1/4) | $60 |
| Filter Sets 1 1/4" (4) #1, #2, #3, #4 | ea $44 |
| Set of 6 Photo Visual Filters (965) Thread In | $60 |
| Series VI Drop-In Filter Set (2045, 2080) | $46 |
| Series V Drop-In Filter Set (908, 97D, 97E, 97ER) | $46 |
| #905 Variable Polarizing Eyepiece System 1 25" | $48 |
| #908 Nebula Filter 1 25" (B) ... $55 (N) | $89 |
| #910 Nebula Filter 2" (B) ... $85 (N) | $119 |
| #911 Nebula Filter (rear cell Thread on) (B) ... $86 (N) | $109 |
| #122 2X Tele-negative Amplifier (for all 8" & 10") 1 1/4" | $40 |
| #126 1 1/4" Barlow (2045.4420) | $39 |
| #127 2X-3X Variable Tele-negative Amplifier | $54 |
| #131 2X Tele-negative Amplifier 965 (291, 294) | $36 |
| #140 2X Tele-neg Amplifier (for all 8" & 10") S/C | $60 |
| #581 Sun Shade (97) #582 (2045) | ea $46 |

| | |
|---|---|
| #710 Dew Shield 10" 2120 | $108 |
| #712 Dew Shield 8" 2080 | $98 |
| #1A Skylight Filter/Dust Seal | $44 |
| #50 Accessory Case ... $59, Case (2080) | $89 |
| (2045S) ... $44, Case (97SS) | $29 |
| Extra 2lb Weights for 1401 or 1402 | ea $20 |
| Tube Balance 2045 | $43 |
| #1401 Tube Balance Weight System 2080 | $69 |
| #1402 Tube Balance Weight System 2120 | $74 |
| Extra Counterweight 25lb, 1" | $66 |
| Extra Counterweight 40lb, 11/2" | $79 |
| #71 Focuser 1 25" ID ... $44, #67 Focuser 1 25" ID | $57 |
| #680-#682 Deluxe Focuser 1 25" & 2" ID | ea $84 |
| #60, #61, #62 T-Adapters | $22 |
| Tele-extender ... $22, Tele-extender (Variable) | $36 |
| Basic Camera Adapter 1 25" 965" | $29 |
| Variable Projection Camera Adapter 1 25" | $39 |
| 2" Prime Focus Adapter | $39 |
| Prime Focus Camera Adapter (.96) | $20 |
| T-Mount Camera Ring Adp'rs (Spec. Camera & Model) | $10 |
| Extension Tube Set (15mm, 30mm, 45mm) | $39 |
| Piggyback Bracket 2080/2120 ... $30, 2045 | $16 |
| #967 9x60 Polar Illuminated View Finder w/bkt. | $133 |
| #637 6X30MM View Finder + Bkt. | $39 |
| #544, 8x50 View Finder w/bracket - SC8 | $76 |
| #781 Electric Motor Drive AD (323, 4420) | $79 |
| #55 Manual Declination Cont. ... $69, #65RS | $106 |
| 48RS Dual Axis Dr. Corrector Sys. | $369 |
| Electronic Control Center | $229 |
| #43 R A Drive Corrector operates from 12VDC | $81 |
| #46 Dual Axis Drive | $259 |
| #47M DA Dr. Corrector Sys | $294 |
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| #38 Declination Motor Ass. 2080 LX3, 2120 LX3 | $78 |
| #38B Declination Motor Assembly 2080, 2120 | $89 |
| #38M Electric Declination System | $89 |
| #39 Declination Motor for LX5, LX6, Premier | $84 |
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| Casters (2" Diameter) for 16" (set of 3) | $38 |
| Leveling Screws (set of 3) for 16" .. $38, for 10" | $29 |
| #868 Extension Tube (2"-10", 16") | $20 |
| Vinyl Dust Cover for 16" ... $26, for 10" | $19 |
| Lens Caps -96 1 1/4" ... 50¢ ea. ... 7 | for $3 |

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|---|---|
| Vinyl Dust Cover pair 6" ... $26, pair 8" | $36 |
| Accessory Shelf for 6"-8"-10" ... $39, for 16" | $49 |
| Accessory Shelf for Field Tripod (2045,2080,2120) | $24 |
| #AD-1 Eyepiece Adapter 965, #AD-2 1 1/4" | ea $18 |

Mirrors, Eq. Mounts - Please call for quotes

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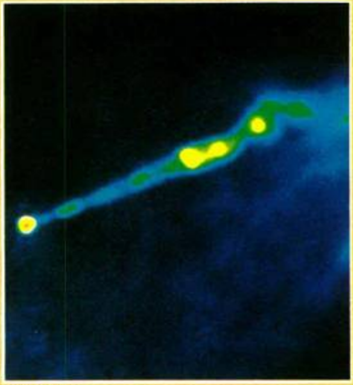

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**THIRTY YEARS OF QUASARS** Three decades of intense scrutiny have shown astronomers that colliding galaxies most likely cause the once-enigmatic quasars.

**HOW WE'LL FIX HUBBLE** NASA sifted through a mountain of suggestions before deciding how to correct the space telescope's faulty optics.

**A PAIR OF EVENING PLANETS** Venus and Mercury make a dazzling duo in the western evening sky this winter.

**ENHANCE YOUR PLANETARY PORTRAITS** If you like to photograph or sketch planets, these techniques can improve your results.

**AVAILABLE ON YOUR NEWSSTAND JANUARY 5**

## Readings & Credits

**What Makes Venus Go? (page 40)**

The issue of the *Journal of Geophysical Research (Planets)* for August 25, 1992 contains many technical papers by Magellan scientists, but they're well-worth looking through. Try a large library.

"Venus: Planet of Fire," by Robert Burnham, Astronomy, September 1991. Images from the first orbital cycle.

"Rendezvous with Venus," by Alan Dyer, ASTRONOMY, April 1991. A look at the stormy Venusian clouds seen by the Galileo space probe.

**Night Visions (page 70)**

"Getting the Exposure Right," by Alan Dyer, ASTRONOMY, September 1992.

"Selecting the Right Slide Film," by Alan Dyer, ASTRONOMY, October 1992.

"Build an Astrophoto Platform," by James Iovine, ASTRONOMY, November 1992. Building a simple camera tracker.

"Capture a Constellation," by Mark Coco, ASTRONOMY, November 1992. How to take star pictures with simple equipment, including camera trackers.

"Taking Pictures with Your Telescope," by Alan Dyer, ASTRONOMY, December 1992.

**First Date with a 2.4-inch (page 80)**

*Edmund Mag 5 Star Atlas*, (Edmund Scientific Co., 1974). A simple star atlas that includes hints on using your scope.

"Soup Up Your Small Scope" by Rick Shaffer, ASTRONOMY, September 1988. Things you can do to improve your scope.

**1993 Sky Calendar (Bonus Insert)**

*Observer's Handbook 1993*, edited by Roy Bishop, (Royal Astronomical Society of Canada, 136 Dupont Street, Toronto, Ontario, Canada M5R 1V2). A comprehensive guide to celestial events.

*Astronomical Calandar 1993*, edited by Guy Ottewell, (Astronomical Workshop, Furman University, Greenville, SC 29613). A large-format guide.

***Cover:*** Tony Hallas and Daphne Mount; ***p. 4***: Bill Hood, an in-camera double exposure, Full Moon at 1/60 second at f/8, landscape at 1/4 second at f/2.8, both with Mamiya 120-format camera with 80mm lens, Ektachrome 64; ***p. 20, top:*** Francesco Paresce (ESA/STScI); ***bottom:*** John Caldwell, Institute for Space and Terrestrial Science; ***p. 22, top:*** European Southern Observatory; ***bottom:*** Richard Ellis/NASA; ***p. 24, top middle:*** Lick Observatory; ***left and right:*** Michael Bolte, University of California, Santa Cruz; ***bottom:*** Sean Sullivan, remotely operated camera, 100mm lens, f/8, 1/250-second, Ektar 25; ***p. 26, top:*** NASA/Paul Hudson; ***middle and bottom:*** Jay Malin; ***p. 28, top:*** Eric Strang; ***midddle, and bottom:*** Alan Dyer; ***pp. 32-33:*** illustration by Ron Miller; ***p. 34:*** illustration by William K. Hartmann; ***pp. 35-36:*** illustration by Ron Miller; ***p. 37:*** illustration by William K. Hartmann; ***pp. 40-45:*** all images JPL/NASA; ***pp. 42-43:*** topographic map courtesy Peter Ford, MIT; ***p. 46:*** ©1984 Anglo-Australian Telescope Board; ***p. 47, top and bottom:*** courtesy Mordecai-Mark MacLow, NASA Ames Research Center; ***p. 48, top:*** courtesy J. Michael Shull, Joint Institute for Laboratory Astrophysics; ***bottom:*** Jack Newton; ***p. 49, left:*** Dave van Buren, IRAS; ***right:*** ©1984 Royal Observatory Edinburgh; ***p. 53:*** James R. Westlake, Jr.; ***p. 55:*** Kim Zussman; ***p. 60:*** Rudolf Schild/Harvard-Smithsonian Center for Astrophysics; ***p. 61:*** Chuck Vaughn, 14-inch f/11 SCT, hypersensitized Tech Pan film, 60-min. exposure; ***p. 62:*** Kim Zussman, 14.5-inch f/8 Cassegrain, hypersensitized Tech Pan film, 120-min. exposure; ***p. 63, top left:*** Preston S. Justis, 10-inch f/6 reflector, hypersensitized Tech Pan film, 80-min. exposure; ***top right:*** K. Alexander Brownlee, 16-inch f/5 reflector; ***bottom:*** K. Alexander Brownlee, 16-inch f/5 reflector; ***p. 64:*** Kim Zussman, 14.5-inch f/8 Cassegrain, hypersensitized Tech Pan film, 200-min. exposure; ***p. 65, top:*** James R. Foster, 11-inch SCT at f/15, hypersensitized Tech Pan film, 150-min. exposure; ***center:*** James R. Foster, 11-inch SCT at f/11, hypersensitized Tech Pan film, integration print made from exposures of 150 and 90 min.; ***bottom:*** K. Alexander Brownlee, 16-inch f/5 reflector; ***p. 67, top:*** courtesy Henry Holt, Greg Leonard, and Brian Cudmik; ***bottom:*** Jack Newton; ***pp. 70-71***: Bill and Sally Fletcher, 8-inch f/4.5 reflector, 70 min., unhypered Fuji 400, copied and sandwiched; ***p. 72***: Ronald E. Royer and Steve Padilla, 4-inch f/5 astrographic lens, tri-color set of 4x5 B&W negatives, printed then rephotographed in register through filters onto Ektachrome sheet film; ***p. 73***: Jay Brausch, July 9, 1991, 3:20 a.m.; ***pp. 74-75***: Larry Landolfi, Oct. 9, 1991, 28mm lens, Velvia film; ***p. 76***: Jerry Schad, 24mm f/1.4 lens, 2 min., Ektachrome P800/1600 processed at ISO 1600; ***p. 77***: Bill Hood, 8-inch Schmidt-Cassegrain, f/10, 45 min., hypered Fuji 400; ***pp. 80-85:*** equipment photos by Darla Gawelski; ***p. 81:*** Lee Coombs; ***p. 85, top left:*** Charles Strickland; ***top right:*** Marc Duncan; ***left:*** Bob Wall; ***right:*** Jacques Guertin and Bill Sorrells; ***p. 87, top:*** Russ Sampson, 35mm lens at f/4, Ektachrome P800/1600 film, 10 min. exposure on August 12, 1992; ***bottom:*** Ronald E. Royer, f/2.8 lens, Vericolor 400 film, 30-min. exposure on August 10, 1992; ***p. 88, top right:*** Bill and Sally Fletcher, 16-inch f/4.5 reflector, tricolor photo using three negatives of 45 min. (red), 75 min. (green), and 90 min. (blue); ***middle:*** Andy Saulietis, 16mm fisheye lens, Photometrics STAR I CCD camera; image processing by Richard Berry; ***bottom left:*** Ronald E. Royer, 12.5-inch f/6 reflector, Tech Pan film, 14-min. exposure on February 28, 1992; ***bottom right:*** Jay Brausch, August 5, 1992; ***p. 89:*** Chris Cook, 105mm f/2.5 lens, hypersensitized Tech Pan film, hydrogen-alpha filter, 70-min. exposure; ***p. 98:*** Darla Gawelski; **Sky Calendar Supplement:** ***Cover***: William Sterne, Tulsa, Oklahoma, Sept. 1990, Mamiya 645 camera, Ektar 25 120-format film, 1-second exposure every 5 min. at f/11; ***January***: John Asztalos taken August 21, 1988; ***March***: Harold Moore; ***April***: August 18, 1990 occultation of Jupiter by Ivan Dryer; ***May***: December 13, 1974 partial solar eclipse by Ernie Piini, ***June***: August 17, 1989 lunar eclipse by Dan Koehler, 94mm f/7 refractor, 1 min. exposure, Ektachrome 400; ***July***: Uranus and Neptune starfield by Terence Dickinson, September 1, 1992, 300mm f/2.8 telephoto, ScotchChrome 400; ***September***: Saturn by Dan Schecter, July 1990, 14-inch SCT, 7.4mm eyepiece projection, 6 seconds; ***December***: Geminid meteor taken December 15,1991 by Villa Mirco, ScotchChrome P800/1600; ***Seasonal Star Maps***: Steven Davis; ***All other diagrams***: Phil Kirchmeier and Tom Hunt.

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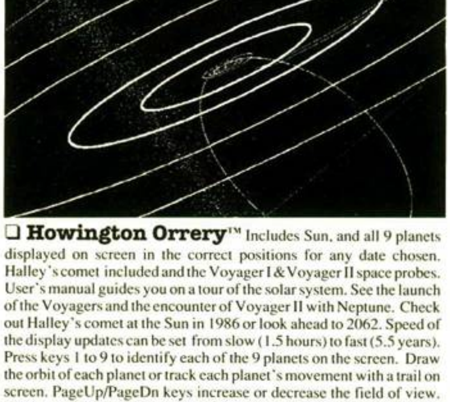

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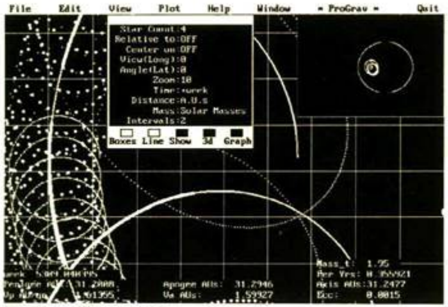

Star Count:4
Relative to:OFF
Center on:OFF
View(Long):0
Angle(Lat):0
Zoom:10
Time:•week
Distance:A.U.s
Mass:Solar Masses
Intervals:2

Apogee AUs: 31.2946
Va AUs: 1.59927
Mass_t: 1.95
Per Yrs: 0.355921
Axis AUs:31.2477
Ecc: 0.0015

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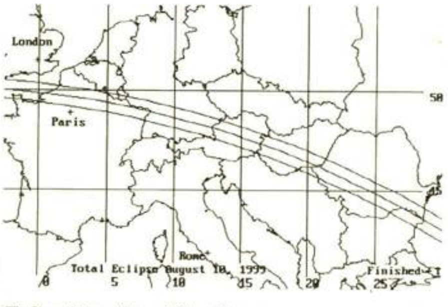

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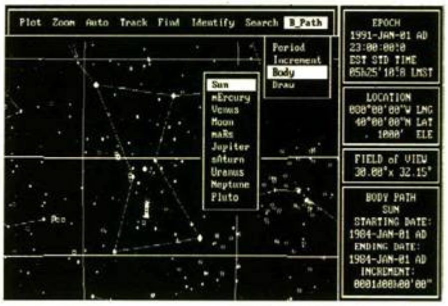

EPOCH
1991-JAN-01 AD
23:00:00:0
EST STD TIME
05h25'10:8 LMST

LOCATION
000°00'00"W LNG
40°00'00"N LAT
1000' ELE

FIELD of VIEW
30.00°x 32.15°

BODY PATH
SUN
STARTING DATE:
1984-JAN-01 AD
ENDING DATE:
1984-JAN-01 AD
INCREMENT:
0001d00h00'00"

Partial Solar Eclipse
Magnitude: 0.170 Obscuration: 0.2x
LAST CONTACT

(••• NGC 3034 Located at TARGET •••)

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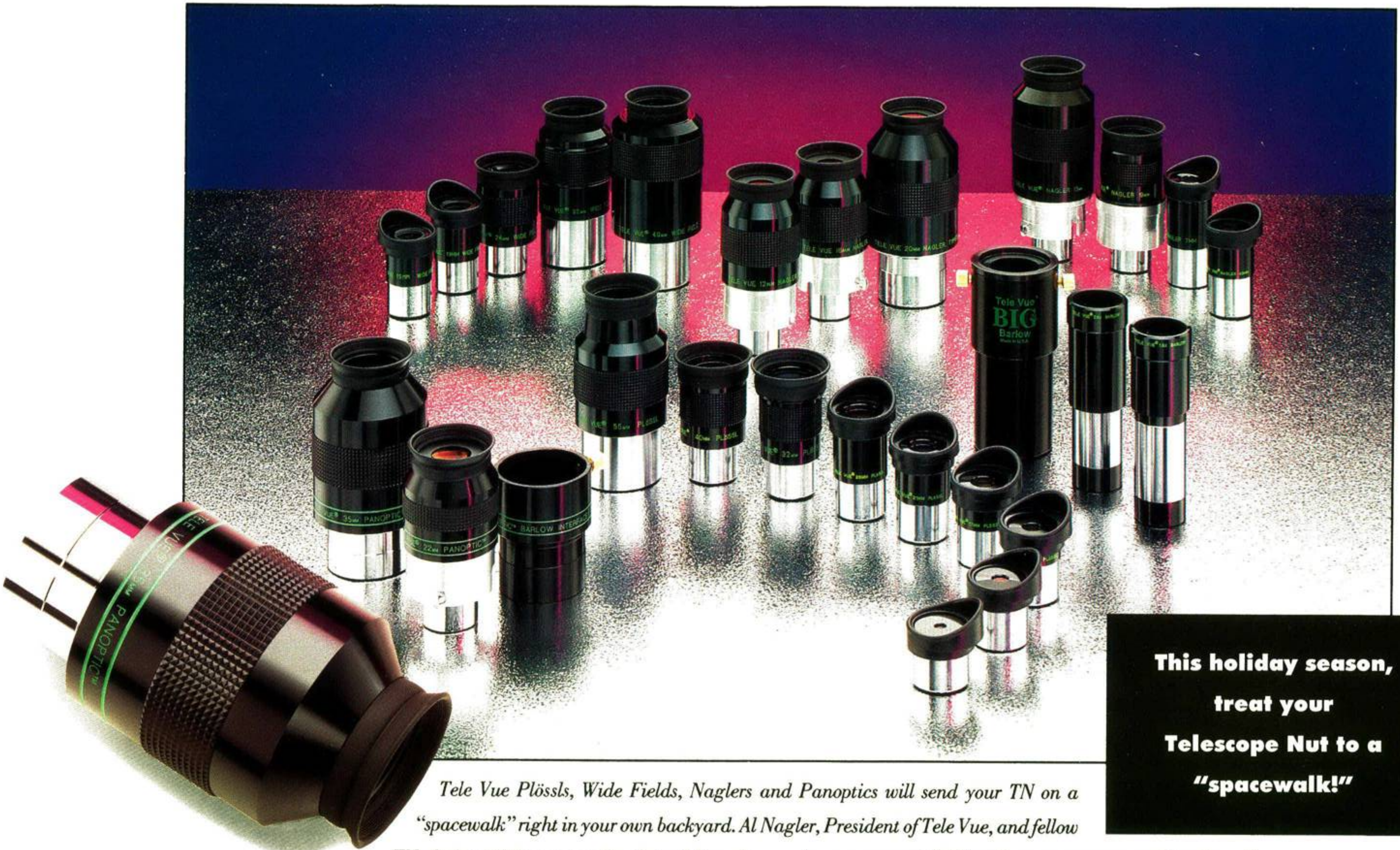

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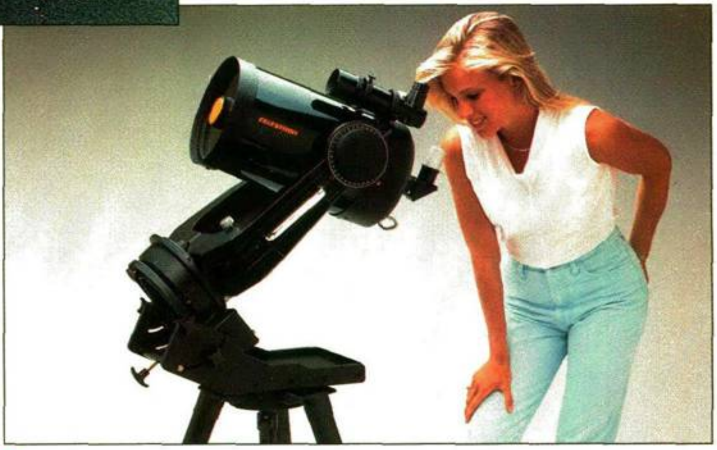
### What makes up a Celestron integrated system?

- **Aperture** - *there is **no** substitute for aperture!*
- **Superior Optics** - Celestron's are the best and most recommended among Schmidt-Cassegrains. Rated most consistent by *Sky & Telescope.*
- **Precision Gear System** - *Sky & Telescope* rated our Byers drive the best in commercial gear systems. Since that review, it has been refined making it even more accurate.
- **Innovative Electronics** - we brought you the first PEC (Periodic Error Correction) electronics. Our compact system requires no bulky, tangled cords. It runs off of a single 9-volt battery.
- **Rigid Mount** - the best in the industry.
- **Solid Tripod** - recent improvements have greatly improved the rigidity.
- **Accessories** - no afterthoughts. Celestron accessories are designed to give you the utmost in performance without compromise.



Why take chances with off-brand products which may produce poor results? All the accessories required to take remarkable astrophotos (like above) are genuine Celestron items.

- **Declination Motor** - *smooth, controllable and vibration-free* (#94141-PEC)
- **Counterweight Bar System** - the finest ever produced (#94191) ***New!***
- **Reducer/Corrector** - transforms the f/10 optics to f/6.3 while improving image quality. A 4-element *fully multi-coated design that's terrific both visually and photographically* (#94175) ***New!***
- **Radial Guider** - the most advanced off-axis guiding system ever produced! The angle of the prism is tunable and its position rotatable while maintaining a fixed camera orientation (#94176) ***New!***
- **Micro Guide Eyepiece** - a multi-coated 12.5mm Abbe Orthoscopic design. The most versatile guiding eyepiece ever offered. It has a finely etched micrometer scale and greatly improves off-axis guiding (#94171) ***New!***
- **MFFT-55** - the ultimate advancement for achieving critical and exact focus (#94200). ***New!***

**REDUCER/CORRECTOR #94175** **RADIAL GUIDER #94176** **MICRO GUIDE #94171** **MFFT-55 #94200**

For more information call Celestron:

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